METHODS OF ASSESSING BENEFICIARIES FOR A SHARE OF THE COST OF PUBLIC WATER CONTROL PROJECTS THAT ENHANCE AGRICULTURAL LAND VALUES

By

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CHAPTER I

INTRODUCTION

During the history of water and other public resource development projects in the United States, a consistent policy for economic evaluation has never been developed. Each of the agencies responsible for carrying out projects have developed and applied their own procedures. Variations in nature and responsibility of the agencies often affected the type of program selected, with choice often based more on political rather than economic consideration.[1]

In 1946, the Federal Inter-Agency River Basin Committee appointed a "Subcommittee on Benefits and Costs" for the purpose of developing uniform standards and principles for determining benefits and costs for water resource projects. After considering different approaches to the problem, this Subcommittee presented its conclusions in the form of a report known as the "Proposed Practices for Economic Analysis of River Basin Projects." In May, 1950, the Federal Inter-Agency River Basin Committee[2] adopted this report as a basis for consideration by the participating agencies. Today the report is known as the "Green Book" and is

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[1] An interesting reading on this subject may be found, for example, in Ben Moreell's Our Nation's Water Resources—Policies and Politics (Chicago: University of Chicago Press, 1956). Also in Arthur Maass' Muddy Waters—The Army Engineers and the Nation's Rivers (Cambridge: Harvard University Press, 1951).

[2] A voluntary committee of U. S. Government agencies created by a memorandum of agreement in 1943, and now consisting of the Departments

used as a guide for existing agency practices. Nevertheless, these practices still have not been wholly adopted by all agencies responsible for resource development projects, and variation in requirements still exists.

In 1958, Otto Eckstein[1] published a critique of the procedures the federal government was then using in the evaluation of water resource development projects and made some suggestions regarding how they might be improved. Other major books in the field include those by Roland McKean,[2] John Krutilla and Otto Eckstin,[3] and Jack Hirshleifer, James C. DeHaven, and Jerome Milliman.[4] None of these authors adequately examined the problems in equity that are inherent in all resource development projects. Krutilla and Eckstein stated, "We leave to the political process in our representative government the problem of distilling a consensus as to which among the several income distributive consequences is most consistent with the prevailing set of ethical values."[5]

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of the Army, Interior, Agriculture, Commerce, The Federal Power Commission, and the Public Health Service.

[1]Otto Eckstein, Water Resource Development: The Economics of Project Evaluation (Cambridge: Harvard University Press, 1961).

[2]Roland N. McKean, Efficiency in Government through Systems Analysis (New York: John Wiley, 1958).

[3]John V. Krutilla and Otto Eckstein, Multiple Purpose River Development—Studies in Applied Economic Analysis (Baltimore: The Johns Hopkins Press, 1963).

[4]Jack Hirshleifer et al., Water Supply—Economics, Technology, and Policy (Chicago: The University of Chicago Press, 1963), pp. 36.

[5]John V. Krutilla and Otto Eckstein, op. cit., pp. 12.

A revision of the "Green Book" published in May, 1958, contains several changes that indicate that the practices of federal agencies are subject to review and change, and reiterates the statement that:

> The question of whether or not charges for project services should be made and the determination of the way in which they should be made are matters of public policy beyond the scope of this report.[1]

Nevertheless, the subcommittee did suggest that the value of the benefits of resource development projects might be evaluated either on the basis of the cost incurred for the service, or the value of the service rendered, without regard to project costs.[2] The subcommittee further suggested that, when benefits are evaluated on the basis of services rendered and without regard to the costs of providing the services, the costs may be defrayed by:

1. Charges for project services based on rates established through competition.
2. Charges to beneficiaries based on benefits received.
3. Charges based on ability of beneficiaries to pay.
4. A combination of the above methods.

On the other hand, when benefits are evaluated on the basis of costs, these costs might be defrayed by:

1. Appropriation from public funds.
2. Charges to beneficiaries at a rate that returns the cost.

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[1]Subcommittee on Benefits and Costs, Report to the Federal Inter-Agency River Basin Committee: Proposed Practices for Economic Analysis of River Basin Projects.

[2]Ibid., pp. 56-57.

3. Charges to beneficiaries at a rate that returns a fixed or sliding portion of the cost.

4. Charges to beneficiaries in proportion to benefits received.

5. Charges to beneficiaries in propotion to the separable costs of serving each beneficiary or group.

6. A combination of the above methods, such as setting charges within the range established by separable costs as a minimum, and benefits or alternate costs as a maximum.

Purpose

The purpose of this study is to examine how the cost of publicly financed water control projects are distributed among the beneficiaries and to determine the extent to which different methods of allocating these costs are based on recognized economic principles and meet welfare criteria.

Procedure

The analysis will be based on the hypothesis that requiring beneficiaries to share in the cost of resource development projects is a tool which can be used to:

1. Achieve an efficient allocation of resources, and at the same time,

2. Produce a distribution of benefits consistent with public policy objectives and welfare criteria.

It is further postulated that the criteria for assessing the costs of and distributing the benefits derived from water resource projects can be supplemented by more objective standards.

In testing these hypotheses, alternative methods of evaluating projects are examined in Chapter II.

Several methods of estimating the rate of interest that may be charged for public funds are presented and the impact of using this method in allocating the cost of water control projects are evaluated in Chapter III.

Chapter IV is devoted to the appraisal of how well the market evaluates public goods and services.

In Chapter V, a flood control and drainage project of the Central and Southern Florida Flood Control District is selected as a case study for the purpose of illustrating how the analysis can be applied.

In Chapter VI, the manner in which property taxation affects economic development is considered.

The effect of two methods of assessing land values and the development of agriculture in a region is examined in Chapter VII.

Finally, a third method of assessment of land values for the purpose of allocating the cost of water control projects is proposed in Chapter VIII.

Insofar as possible, neo-classical economic principles will be used, but value judgments cannot be excluded entirely whenever the distribution of wealth is considered. As Hirshleifer et al., stated, "Now economics can say something of the distributional consequences of alternative possible policies, but what it says stops short of any assertion that any man's interests or well-being can be preferred to another's. The fact that economics has nothing to say on such matters does not mean, of course, that nothing important can be said."[1]

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[1]Hirshleifer et al., op. cit., pp. 36.

CHAPTER II

THE ECONOMICS OF PROJECT EVALUATION

In this chapter an attempt is made to evaluate one of the most important concepts used by agencies which are engaged in water resource development, namely, the benefit-cost ratio. Such an evaluation will be related later to methods of assessment.

Alternative Methods of Project Evaluation

Three methods of determining the relative economic value of projects are identified in the "Green Book."[1]

1. Comparing the amounts of benefits over cost for several projects.—This method indicates which projects produce the greatest net benefits, without regard for the relative costs of realizing benefits. A comparison of the difference between benefits and costs is rejected because this criterion obviously favors large projects over small ones. Also, two projects with an equal surplus of benefits over costs would appear equally desirable in such a comparison even though the costs of one may be several times that of the other. The usefulness of this comparison is limited to instances where relative costs are not a consideration.

2. Comparing return on investment in several projects.—This is made by computing the percentage of the annual benefits over annual costs

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[1]The following material is abstracted from Proposed Practices for Economic Analysis, op. cit., pp. 14.

to the investment in each. Operation and maintenance costs are deducted before the percentage is computed. This method also has a limited usefulness. It may be used to determine the relative desirability of projects when (a) construction funds are limited, and (b) the relative cost of operation and maintenance is considered of secondary importance.

3. Comparing the ratio of benefits to costs.—The Subcommittee on Proposed Practices stated that "If the sum of all beneficial effects were compared with the sum of all adverse effects for a project, the ratio of the benefits to the costs would reflect the effectiveness with which all the resources involved were being used."[1] This is the recommended basis for comparing projects that are constructed by the Bureau of Reclamation and the Army Corps of Engineers.

The Nature of the Benefit-Cost Ratio

To calculate benefit-cost ratio, both the annual benefits and costs must be estimated. The preliminary steps are first to spread the installation costs over time, by converting them to annual costs, and then adding the average annual operating costs; second, to estimate the value of the project's average annual output. The streams are discounted for the purpose of determining the present value of costs and benefits, and the "annual equivalents" of these present values. The final step is to compute the ratio of annual benefits to annual costs.

The limitations of using this benefit-cost ratio as a criterion can be illustrated by two examples based on McKean's hypothetical data.

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[1] Ibid., p. 14.

Projects A and B both require investments of $10 million to be written off in 10 years. The annual costs, annual benefits, and the benefit-to-cost ratio are shown in Table 1.

TABLE 1

ANNUAL BENEFIT TO COST RATIOS FOR HYPOTHETICAL PROJECTS A AND B

	Project A	Project B
Initial Investment	$10	$10
Annual Benefits	15	05
Annual Costs	05	01
Ratio of Benefit to Cost	3/1	5/1

If capital must be rationed and only one project can be undertaken, project B is recommended on the basis of the benefit-cost ratio, but its net income over the period is less than that yielded by A as is shown in Table 2. The benefit-cost ratio is the wrong test in this case. Table 1 simply shows the relationship between total receipts and total outlays for each project. However, Project A would be recommended on the basis of its net effect on the community over the life of the project (see Table 2). In this instance, the "Prospective change in present worth" is the criterion.

The most significant test of the desirability of making public investment is not the ratio of gross benefits to total costs. The only thing revealed by this ratio is whether or not some net return can be

TABLE 2

NET INCOME FROM HYPOTHETICAL PROJECTS A AND B

	Project A	Project B
Annual Benefits	$15	$ 5
Annual Costs	05	1
Net Income Each Year	10	4
Net Income Over Life of Project (10 years)	100	40

expected, or whether or not the project has a favorable benefit-cost ratio before it is constructed. Such a ratio is useless in judging the relative merits of projects whose ratios are greater or less than unity. If the benefit-cost ratio is used for the purpose of weighing the relative merits, then a project with high gross returns and also high operating costs will be at a relative disadvantage, whatever its potential contribution to net worth may be. Actually there is no single test which can be used to select the result in the optimum economic development of an area. Any single criterion must be regarded as only a partial one. According to R. N. McKean, "One of the most significant partial tests which is regarded as the 'right' criterion of the economically efficient set of investment - is the maximization of the present worth for a given investment budget, when the streams are discounted at the marginal internal rate of return."[1] The hypothetical data for projects A and B shown in

[1]McKean, op. cit., pp. 117.

Table 3 illustrate this point. In this case the ratio of the present value of benefits to the present value of cost is used as the criterion for selecting one project over the other.

The Calculation of Present Worth of Costs and Benefits

In the example illustrated in Table 3, it is assumed that the benefits of the project are constant throughout the life of the project (20 years) and the present worth of the future benefit stream discounted at 5 per cent interest is found by using the formula

$$V_0 = S\left[\frac{(1+i)^n - 1}{i(1+i)^n}\right]$$

Where V_0 is the present value of the stream of benefits, S is the value of the annual net benefit (benefit less cost), i is the discount or the interest rate per annum, n = the number of years (life of the project).

The present worth of 20 years' benefit stream discounted at 5 per cent per annum is

$$V_0 = 70{,}000\left[\frac{2.653-1}{(.05)(2.653)}\right] = 70{,}000\ \frac{1.653}{.13265}$$

$$= 70{,}000\ (12.4613)$$

$$= 872{,}200$$

The present worth of the operating costs is found by the use of the same formula by replacing C_0 for V_0 and c for s:

$$C_0 = c\left[\frac{(1+i)^n - 1}{i(1+i)^n}\right]$$

Where C_0= the present value of the operating costs stream.

c = the annual operating costs.

TABLE 3

COMPARISON OF ANNUAL BENEFIT-COST RATIOS OF PROJECTS A AND B WITH RATIOS OF PRESENT VALUE OF BENEFITS TO PRESENT VALUE OF COSTS

	Project A		Project B	
Initial Investment		100,000		100,000
Annual Operating Costs		50,000		50,000
Annual Benefits		70,000		20,000
Present worth of 20-year cost stream discount at 5%:				
Initial Investment	100,000		100,000	
Operating Costs	623,000		62,300	
Total		723,000		162,300
Present worth of 20 years' benefit stream discounted at 5%		872,200		249,200
Increase of present worth: Present value of benefits minus present value of costs		149,200		86,000
Ratio of present value of benefit to present value of costs		1.21		1.54
Mean Annual Benefits		70,000		20,000
Mean Annual Cost:				
$[100,000 + (20 \times 50,000)] \div [20]$		55,000		—
$[100,000 + (20 \times 5,000)] \div [20]$		—		10,000
Ratio of mean Annual Benefits to mean Annual Costs (The Benefit-Cost Ratio)		1.27		2.00

The present worth of the 20 years' operating cost stream discounted at 5 per cent is:

$$C_o = 50\left[\frac{(1 + .05)^{20} - 1}{(.05)(1 + .05)^{20}}\right]$$

$$= 50{,}000\left[\frac{2.653 - 1}{(.05)(2.653)}\right]$$

$$= 50{,}000\left[\frac{1.653}{1.3265}\right]$$

$$= (50{,}000)(12{,}4613)$$

$$= 623{,}000$$

When the stream of benefits or costs to be discounted is constant but perpetual beginning with time 1, so that $s_1 = s_2 = s_3 = s_t \ldots$ to infinity, we may write the present value as:

$$V_o = \frac{s_1}{(1+i)} + \frac{s_2}{(1+i)^2} + \frac{s_3}{(1+i)^3} + \ldots + \frac{s_n}{(1+i)^n} + \ldots$$

$$= S\left[\frac{1}{(1+i)} + \frac{1}{(1+i)^2} + \frac{1}{(1+i)^3} + \ldots + \frac{1}{(1+i)^n} + \ldots\right] = \frac{S}{i}$$

If the stream to be discounted is expected to increase or decrease in the future and is perpetual, the formula is modified as follows:

$$V_o = \frac{S}{i} \pm \frac{m}{i^2}$$

Where m is the average annual "increment" of increased or decreased net return that is expected to result from a water control or some other development project. When the increment of increased or decreased return is expected to continue for a specific number of years and then is followed by a period of relatively constant returns, the formula is changed to:

$$V_o = \frac{S}{i} \pm \frac{m}{i^2}\left[1 - \frac{1}{(1 + i)^n}\right]$$

The Present Value and the Benefit-Cost Ratio

The present value of total costs can be written in a different form:

$$\sum_{n=1}^{N} \frac{O}{(1+i)^n} + K$$

and the present value of total benefits is:[1]

$$\sum_{n=1}^{N} \frac{B}{(1+i)^n}.$$

The benefit cost ratio is:

$$\frac{B}{C} = \sum_{n=1}^{N} \frac{B}{(1+i)^n} \left[\sum_{n=1}^{N} \frac{O}{(1+i)^n} + K \right]^{-1}$$

Putting the ratio on an annual basis by dividing the numerator and denominator by

$$\sum_{n=1}^{N} \frac{1}{(1+i)^n}$$, the benefit-cost ratio formula becomes:

$$\frac{B}{C} = \frac{B}{O + K\left[\sum_{n=1}^{N} \frac{1}{(1+i)^n}\right]^{-1}},$$

and letting $\left[\sum_{n=1}^{N} \frac{1}{(1+i)^n}\right]^{-1} = A_1 N$,

where $A_1 N$ is the annual capital charge per dollar of fixed investment representing both interest and amortization.

The ratio can now be written:

$$\frac{B}{C} = \frac{B}{O + (A_1 N) \cdot K}$$

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[1]Where i and O are defined and before . B = Benefits received annually. K = fixed investment. n = amortization period.

The benefit cost ratio is usually presented in the form of the latter equation.

Given i and n, numerical values for ($A_{\overline{i}|}$ N) can be obtained from a table called "Annuity whose present value is 1."[1]

Project Evaluation by Other Methods

Streams of benefits and costs can also be used to evaluate projects by transforming them into equivalent constant flows and compare the ratios of annual profits to investment. Firms and investors often prefer to think in terms of annual profits and percentages of profits on investment rather than in terms of internal rates of return. Annual gains, costs, and rates of profit on investment can be calculated in numerous ways, and some of these ways may lead to an erroneous evaluation and ranking of projects. This point is illustrated in Table 4. A discount rate of 5 per cent is used to calculate the present value of the streams. The present value of the cost stream consists of the sum of $110 discounted for 1 year, $10 discounted for 2 years, $10 ids-counted for 3 years and so on.[2]

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[1]The table is presented in Mathematical Tables for Physics and Chemistry, published by the Chemical Rubber Company (C.R.C.) 12th edition. pp. 468-475.

[2]By using the formula $P = S(1+i)^{-n}$, where P is the present value of the stream, S is the accumulated value of P after a certain time n. Values of $(1+i)^{-n}$, the discount factor, for various rates of interest and various times n are given in tables of compound interest. The present value of the benefit stream is calculated as follows:

$P = S(1+i)^{-n} = 60\ (1+i)^{-5} = 60(.7835) = 47.01$

$P = \quad\quad 60\ (1+.05)^{-4} = 60(.8227) = 49.36$

$P = 40\ (1.05)^{-3} = 40\ (.86384) = 34.55$

$P = 20\ (1.05)^{-2} = 20\ (.907003) = 18.14$

$47.01 + 49.36 + 34.55 + 18.14 = 149.06$

TABLE 4

PRESENT VALUES AND ANNUAL PROFITS ON INVESTMENT

Year at End of Which Benefits or Costs Occur						Present Value of Stream (5% interest)	Annual Equivalents of Present Values	Straight Line Annual Average	Average Receipts In Operating Years, and Amortized Costs
	1	2	3	4	5				
Receipts	0	20	40	60	60	$149.06	$34.43	$36.00	$45.00
Costs	110	10	10	10	10	138.53	31.99	30.00	29.91
Annual Net Profits							2.44	6.00	15.09
Annual Rate of Profit on Investment							2.2%	5.5%	13.7%

The annual equivalents of the present values are the present values amortized, with interest at 5 per cent, over the 5-year period. This means receipts are the annual payments that one receives in order to collect an amount equivalent to the present value of the receipt stream.[1] Costs are the annual payment that one must make in order to pay an amount equivalent to the present value of the cost stream. The straight-line annual averages are the totals for the period, undiscounted, divided by the number of years in the period. The average receipts in operating years is the simple sum of receipts divided by the number of years after completion of the investment, and "amortized costs" is simple annual operating cost plus the annual payment that amortizes the initial investment over the period (19.91).

Such variation of the annual rates of profits on the investment will lead to divergent interpretations which may cause a great deal of confusion.

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[1]The annual equivalent of the present value, denoted as R, is the present value amortized at the interest rate. R is obtained by using the formula $R = A. \frac{1}{a_{\overline{n}|}i}$ Where R = the annual equivalent of the present value.
A corresponds to the present value of fixed investment, or the initial investment itself. $a_{\overline{n}|}i$ = the present value of an annuity of 1 per payment interval for n intervals. It can also be written: $\frac{1-(1+i)^{-n}}{i}$

In the example given in Table 3, $\frac{1}{a_{\overline{n}|}i} = \frac{1}{a_{\overline{5}|}.05} = 0.2309748$

$R = (149.06)(0.2309748) = 34.43$
$R = (138.53)(0.2309748) = 31.99$

CHAPTER III

THE INTEREST RATE AND CAPITAL RATIONING

The problem of resource development, which is a problem of resource conservation, implies that consideration must be given to the interests and desires of future generations. The market does not in itself provide a way for the needs and desires of unborn generations. The decisions actually made through the market are almost one-sided. This is one of the imperfections in the capital market. The market discount rate which in principle reflects a balance between time preferences and the productivity of current funds in terms of future funds is affected by a variety of government policies. Besides, the government is the agency for certain collective spending and saving decisions. The policy used to stabilize the over-all level of the economy can affect the interest rate.

The choice of an interest rate involves fundamental social value judgments about benefits accruing to different generations and about the over-all objectives.

In an undeveloped region or nation, a policy of favoring the future over the present by forcing a rate of growth greater than that which would come about automatically could be achieved by lowering the rate of interest. This is in addition to the imperfections of the market itself. With the durability and high capital intensity of most multi-purpose water control projects, the use of a low interest rate would yield an altogether different kind of program than a high interest rate.

The interest rates which are applied in actual agency practice are those which approximate the rate on long term federal securities. The Subcommittee on Benefits and Costs recommended a rate of 2.5 per cent on federal and non-federal government costs, and a rate of not less than 4 per cent for private costs and for all benefits.[1] The basic principle used in the "Green Book" analysis is that the discount rate should equal the expected long term borrowing rate of the agency involved, whether private or government.

Whether or not the government bond rate measures the social cost of capital employed in water resource projects is a matter which needs further investigation. If a government sought to raise funds for resource developments in the capital market, it would find lenders willing to supply the money at the going federal bond rate. This may be taken as an evidence that the social cost of the loan is measured by this rate. But this line of reasoning overlooks two fundamental factors.

The first factor is the social cost of risk bearing. Risk is two kinds: (a) the borrower's risk determined by the riskiness of the venture, whether or not the expected income stream will materialize, and (b) the lender's risk, which is related to the financial strength of the borrower, whether or not he will be in a position to repay the loan when it is due.

In the case of federal investment projects, lender's risk is very small. The holder of a federal bond need not be concerned with the

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[1]Subcommittee on Benefits and Costs, op. cit., pp. 21-24.

success of a specific water-resource project or other programs of the government. The interest rate on federal securities, as compared to other rates in the economy, is relatively low because of the low lender's risk. If a project fails to produce the expected benefits, the loss is socialized, and the taxpayer makes up the loss.

Thus, the federal bond rate does not measure the full social cost of capital invested in water resource development projects since it fails to make an allowance for the borrower's risk.

A second factor in the argument in favor of the government bond rate assumes that the money is actually raised through voluntary bond sales to the public, which is not the case. An increase of the federal water-resources program in time of full employment will require an increase of taxation or a reduction of other expenditures if the government pursues fiscal policies designed to help stabilize the economy. Without a voluntary individual choice with respect to payment of taxes, the social cost of money raised in this way depends upon the circumstances in which the households and businesses who pay the taxes find themselves. If the increase of expenditures in the field of water resource program leads to the curtailment of expenditures in other fields, the social cost of capital will depend on the value of marginal expenditures in other alternatives.

The Rate of Return on Private Investments

It has also been suggested that public projects should earn a rate of return equal to good private investments, hence an interest rate equal to private rates of return be used in the benefit-cost analysis.

It is argued that the capital employed in public projects could be used in fields of private investment instead, where it would earn a high rate of return. An optimal allocation of investment in the economy would require that the rate for public investment should be as high as the rate in the private sector in order to maximize the total increase in national income.

This line of reasoning assumes that an expansion of public investment leads to a contraction of private investment in equal amount, or that a contraction of public investment would result in an equal expansion in the private sector. In a private corporation this type of investment is a "marginal" investment and its growth is constrained by federal business taxes. Moreover, since public investment is financed primarily out of taxation, much of which is paid by households, its expansion would largely be at the expense of consumption.

Thus the rate of return on good private investments also holds little justification for public projects.

The Opportunity Cost of Capital

The rate which would be an appropriate measure of the social cost of federal capital must be estimated by tracing the capital to its source and by discovering its value in the absence of the public project. Since the money is actually raised by taxation, the incidence of the marginal taxes which are required by a project must be assigned to various businesses and households.

The increase or reduction of taxes must be assumed and assumptions about the incidence of these taxes (the sector of the economy which bears

the cost of these taxes) must be made. Once the tax is traced to its source, its value in the alternative use can be estimated.

In the case of taxes falling on business, some decline in investment will occur but the exact magnitude will depend upon the availability of investable funds in relation to the firm's opportunities. Some rate of return would have been earned on these investments.

A decline in the firm's investment makes a part of the total tax levied on the firm. The remainder of the business tax reduces the liquidity of the firm and tends to reduce funds available in the general capital market.

As for taxes falling in households, in order to estimate a rate of return to the money raised from this source, it is necessary to accept consumers' sovereignty with regard to time preference decisions. Whatever time preference individuals attach to the marginal dollars which they borrow or lend reflects the relative satisfaction of present consumption versus future consumption. The marginal borrowing or lending rate (the rate at which they borrow or lend the last dollars) at which they voluntarily exchange present versus future consumption is the best measure of this time preference. A household which is willing to borrow at an interest of 10 per cent in order to increase present consumption must be assumed to have a time preference of this magnitude. The household's income which is taxed away for the sake of a public project represents a social cost measured by that interest rate. It would take a rate of that magnitude to have the consumer voluntarily lend his money in order to permit the public investment. Taxation is one of the coercive powers

of government. To measure the social cost of a forced loan which taxation for public investment represents we must look to the interest at which the household operates in its market transactions.

Krutilla and Eckstein presented an elaborate analysis of the social cost of federal financing. They examined possible alternative ways of securing federal funds and measured different impacts of the alternatives upon the various investing and consuming sectors. In the case of the personal income tax, a reduction of which is considered as an alterative to a water-resource project, the incidence of the reduction is traced through various income groups. The next step is to average, on the basis of family-budget information, the rate of interest yielded on investments (or saved by repayment of debt) for each income group. The results, under 1955 market conditions, are an opportunity rate of 5 to 6 per cent for the social cost of federal capital.[1] An interest rate of 5 per cent is used in this study, the conservative estimate of the two figures.

Capital Rationing

Capital rationing is a situation in which the decision-making body is constrained to select investments that fall within, or just exhaust, a certain fixed investment budget.

There are two different ideas about rationing. The first is the specific rationing, a case in which the decision-making body has a certain amount of current funds to be disposed of through investment in projects.

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[1]Krutilla and Eckstein, op. cit., pp. 78-130.

The second idea invokes maximum rationing. Here, the decision maker can invest up to, but not in excess of, the maximum amount indicated.

Under capital rationing the investor cannot borrow more funds for current use. Some form of imperfection of the market constrains him to work only with the funds initially available to him.

Investment Under Capital Rationing

The solution to the problem of investment under capital rationing is to use the internal rate of return on the marginal project as the discount rate in the present value calculations, as recommended by McKean.[1]

A decision-making body would rank all projects in the decreasing order of the internal rate of return and select projects from top of the list until the total cost of projects selected exhaust the fixed budget in the case of a specific rationing, or until the marginal internal rate of return just equals the value of an alternative use of the funds in the case of a maximum rationing. Under capital rationing, therefore, the yield of a project is its internal rate of return. The marginal internal rate of return is the rate at which the present value of the "marginal" project's receipt stream is equal to the present value of its cost stream, or, the rate of discount which makes the present worth of the "marginal" project zero. On the "marginal" project, if a $100 investment provides $5 a year in perpetuity, its internal rate of

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[1]McKean, op. cit., pp. 76-81.

return is 5 per cent. This means that, with a discount rate of 5 per cent, the value of the receipt stream of $5 a year is $100 and this is equal to the cost stream (the initial investment of $100). The 5 per cent in this case is the marginal internal rate of return, the discount rate which is used under capital rationing.

McKean's procedure is criticized on the ground that it amounts to determining the discount rate by the internal rate of return on the "marginal" project. The marginal project may have an ambiguous internal rate of return.[1] Besides, this rate fails to consider the market terms, the terms on which funds needed later in the project history can be obtained. Also it does not take into account the market earning value of the cash proceeds thrown off by the project, which is a necessary condition for establishing a correct marginal internal rate of return.

One argument in favor of using the marginal internal rate of return as a basis for selecting projects is that the limited budget of an agency may require it to stop investing when it still has projects capable of yielding, say, 12 per cent, despite the fact that the market market rate of interest is lower, say, 6 per cent. Here discounting at the market rate may lead to the adoption of a project yielding only 6 per cent, which would be a mistake if alternative investments yielding more are available.

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[1]Hirshleifer et al., op. cit., pp. 154 and 167. The determination of this rate requires a technique of successive approximations. Sometimes there may be one, two, or any number of solving rates of interest. The technique of successive approximations which is necessary to obtain a single solution does not give any clue as to whether other solutions exist.

If the "marginal" project's internal rate of return is the same as that of the market, it will have a zero present worth when the market rate is used for discounting. If the marginal project's internal rate of return is less than the market rate, the investment will have a negative present worth when the market rate is used to discount the streams.

Without capital rationing, the rule of the internal rate of return states that one should invest until the internal rate of return from incremental investment is no higher than the market rate of interest. To invest until the next-best opportunity yields no more than the market rate means to undertake all projects which have positive present worth when discounted at the market rate of return. In this situation the "market rate" is the same as the "marginal rate of return" which could be earned on further investments. This rate is also the "marginal internal rate of return."

In principle, if the size of the investment budget can be adjusted to conditions in the general investment market, then the discount rate should reflect these investment opportunities. If there is no way to borrow enough capital to undertake all the investments that would be profitable at the going market rate of interest, investment cannot be pushed to the point at which the additional gain is equal to the additional cost. Available capital is fixed in this case, and the next-best investment opportunity would yield more than the market rate. In this case investment capital should be discounted at a "higher" rate so that less lucrative investments are not undertaken.

One method to determine the marginal internal rate of return is to discount the streams of net benefits at various rates and find the discount rate at which the budget is exhausted by projects with a positive present worth, that is, with gain streams whose present values exceed those of their cost streams. The lower the rate used for discounting, the larger the amount of investment which is economically justified, that is, the one which has a positive present worth. At some rate of discount, the amount of economically justified investment is equal to the budget. This rate is equal to the marginal internal rate of return, the rate that makes the marginal project have a zero present worth. These projects with positive present worths that exhaust the budget constitute the correct set, the one which yields the maximum present worth with the given investment budget when the streams are discounted at the marginal internal rate of return.

Maladjustment between time preferences in consumption and the marginal rate of return in production is possible whenever capital rationing exists. Capital owners may attach a high value to receipts in a particular year for consumption purposes, not for investments. In this situation we get a different set of time preferences which nullifies the test: maximization of present worth when the streams are discounted at the marginal rate of return.

Regardless of inconsistencies with time preferences, the objective is to maximize yields over the planning period, that is, to obtain maximum growth of asset values through the period. Investments are not undertaken with the intention to consume the capital. Owners of capital

reinvest their incomes with the intention at least to maintain their stock of capital. Neither a private investment department nor a government agency knows what its investment will be in the future years, or just how much of the resources will be devoted to that investment budget and how much to consumption. There is uncertainty about future investment opportunities and also about how valuable funds will be for consumption purposes. Therefore the private investment department or the government agency must assume that the capital invested is not to be liquidated, that net receipts are to be reinvested, and that maximum return over the period under consideration is to be sought. The test should be maximum present worth for the given investment budget when the streams are discounted at the marginal rate of return.

Alternative Methods of Ranking Projects

The Present-Value-Per-Current-Dollar Method

A procedure leading to a correct result as long as funds for the current period are assumed to be rationed is to compare projects on the basis of present value as of time 1 (the value of the time stream for periods 1 through n, calculated back to time 1) per dollar of current funds.[1] The means for ranking projects is $\frac{V_1}{C_0}$ where

$$V_1 = S_1 + \frac{S_2}{(1+i)} + \frac{S_3}{(1+i)^2} + \ldots + \frac{S_n}{(1+i)^{n-1}}$$

and C_0 is the fund input incurred in the current period at time 0. A constant market rate of interest i is assumed.[2]

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[1] Hirshleifer et al., op. cit., pp. 172.

[2] If the interest rate is not constant, the formula becomes

The rule is to adopt, successively, projects with the highest values of $\frac{V_1}{C_0}$ until the fixed budget is exhausted in the case of a fixed ratio, or until the alternative use of funds elsewhere becomes more desirable than further investments in the case of a maximum ration. The market rate is used for discounting between all periods except the current period because market transfer of funds through borrowing or lending between all periods is permitted, except for the current one. The government agency should stop investing when the "marginal time productivity" on investments, which is the ratio $\frac{V_1}{C_0}$ on the marginal investment, falls to an equality with the "marginal time preference" between current and future funds. This method involves the smallest departure from the present value principle used when capital rationing does not exist.

The Terminal Value-Per-Current-Dollar Method

Instead of discounting all the future terms back to time 1, they are compounded to some terminal date. The compounded value V_n is given by the equation

$$V_n = S_1(1 + i)^{n-1} + S_2(1 + i)^{n-2} + \ldots + S_{n-1}(1 + i) + S_n.$$

With this value the ratio $\frac{V_n}{C_0}$ is found. Under specific rationing, projects would be adopted in descending order of this ratio until current funds were exactly exhausted. Under maximum rationing, it may be desirable to stop before this point is reached if uses of current funds in alternative investments become more valuable on the margin.

$$V_1 = S_1 + \frac{S_2}{(1 + i_2)} + \frac{S_3}{(1 + i_3)(1 + i_2)} + \ldots + \frac{S_n}{(1 + i_n)(1 + i_{n-1}) \ldots (1 + i_2)}$$

The Shadow-Price Method

This method provides a solution to the problem of generalized capital rationing (a fixed capital budget for any number of periods). Projects are evaluated on the basis of present value V_0, adjusted for the scarcity of current funds by charging a special price w for their use, to be written

$$V_0 = -C_0 + \frac{S_1}{(1+w)} + \frac{S_2}{(1+w)(1+i)} + \frac{S_3}{(1+w)(1+i)^2} + \cdots + \frac{S_n}{(1+w)(1+i)^{n-1}}.$$

Different values of w are tried until a level is found such that adoption of all the projects with positive present values V_0 just exhaust the available current funds. In the case of a maximum ration, if the value of w falls below a return z on current funds in alternative uses, then V_1 should be divided through by $(1+z)$ instead of $(1+w)$, or $V_0 = -C_0 + \frac{V_1}{(1+w)}$ where

$$V_1 = S_1 + \frac{S_2}{(1+i)} + \frac{S_3}{(1+i)^2} + \cdots + \frac{S_n}{(1+i)^{n-1}}.$$

Capital rationing does not represent a practically important situation. The size of the government budget ought not to be considered fixed but should usually be determined by the efficiency of the projects. Cases are rare which require the use of the rather complex efficiency calculations which are necessary under conditions of capital rationing.

CHAPTER IV

THE VALUATION OF PUBLIC GOODS AND SERVICES

The Objectives of Public Water Resource Development

The objective of Public Water Resource Development projects is often defined as the maximization of national welfare. Operational methods to achieve such a goal must be worked out. One method of doing this is to use the national income to evaluate national welfare. National income is measurable, but does not include all of the attributes of the national welfare. More specifically, using the national income to measure the national welfare implies that:

1. The non-economic dimensions of welfare are not considered; and

2. Society is totally indifferent as to who receives the income generated by public development projects. "Social indifference as to the distribution of income generated by the system (river development system) implies that the marginal social significance of income is the same regardless of who receives it."[1]

Because society is not indifferent to the manner in which the benefits of a development project are distributed, it is more realistic to evaluate national welfare in terms of both national income and a

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[1]Arthur Maass et al., Design of Water Resource Systems (Cambridge, Massachusetts: Harvard University Press, 1962). pp. 17.

specific plan for allocation of project benefits. More specifically, this may be done by evaluating:

1. Efficiency, which achieves the objective of maximization of the size of the national income in a more sophisticated manner than does the maximization of the national income itself, and

2. Income distribution, which achieves the objective of achieving a desired division of the national income by methods consistent with community values.

The shortcomings of the efficiency objective may be found in this situation: if each dollar of net income generated by water resource development is assumed to be of equal "social significance" regardless of the recipient, then maximization of efficiency, which amounts to maximization of real national income, is a reasonable objective. This is a concept which represents a value judgment that few would accept because it implies that an extra dollar to a millionaire is as socially desirable as a dollar to a struggling farmer.

When the distribution goal and efficiency resource use conflict, the decision becomes a matter of weighing the alternatives, based on an understanding of the extent and significance of the divergences. The cost of efficiency foregone would measure the cost of choosing the distributional goal. The adverse effects on distribution from obtaining optimum efficiency could justify the need for relaxing the efficiency criterion.

The Welfare Objective and Market Values

The difficulty with using the national income for this purpose is that it is too closely tied to market values. If a water resource development project makes large amounts of electric energy available for residential consumers at low cost, it adds more to the national welfare than a second development project which makes smaller amounts of energy available at higher costs, even though the total revenue of the latter project and hence its contribution to the national income is higher (assuming the demand for electric energy is inelastic within the effective price range). This is an important reason why it is more appropriate to replace the size of national income by the more fundamental principle of economic efficiency. The President's Water Resource Policy Commission stated in its report,[1] "There are many types of public objectives and gains which defy analysis in commercial terms. For example, market price valuation can give quite misleading results when applied to public measures designed to stop resources deterioration and to strengthen the resources base of the country. Market prices reflect scarcity values; thus if half our forests were burned, the remainder would be worth more than the existing forests because of the very sharp rise in prices of forest products that would take place. A commercial property has 'dollar' value according to scarcity; a Nation's resources have 'security' value if they are so plentiful as to be cheap. Thus a successful irrigation or drainage program might lead to a great

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[1]The Report of the President's Water Resources Policy Commission, Volume I: A Water Policy for the American People (Washington, D.C., Government Printing Office, 1950), pp. 60-61.

reduction in the dollar value of some particular crop; the more that is planted and protected, the less it is worth; and the 'stronger' is the Nation. This basic conflict between private values based on scarcity and public values based on plenty lies at the very heart of the conservation problem."

In the above example, although the price rise in forest products results in an increase in the national income this increase does not reflect an increase in the national welfare. Instead it detracts from it because it decreases the total amount of forest products available to consumers.

The Costs of Supplying Public Goods and Services

In the case of the "social wants proper," the first type of public wants, market mechanism fails altogether and the divergence between public and private services becomes all-inclusive.[1] People who do not pay for the services cannot be excluded from the benefits that result. Voluntary payments of consumers are not feasible, hence the market cannot be excluded from the benefits that result. Voluntary payments of consumers are not feasible, hence the market cannot satisfy such wants. An example of such services is the national defense.

Budgetary provisions are needed if a service is to be produced. A determination of the required budget is complicated by two factors, both of which arise because the same amount of the service must be consumed by all citizens. First, true preferences are unknown. A way must

[1]Richard A. Musgrave, The Theory of Public Finance: A Study in Public Economy (New York: McGraw-Hill, 1959), pp. 3-27.

be found to induce people to express their preferences. Governmental institutions can be regarded as agencies for expressing these group demands. If voluntary payments are left to the individual, the result is a very low level of supply of these goods and services. The reason may not be lack of individual appreciation of the benefits of these services but, rather, the fact that an individual's payment is made to the advantage of all. The individual may voluntarily pay little or nothing for a good, but may willingly pay a large amount for the same good on the condition that others do so. Therefore, budgetary action is needed to correct individual choices. Altruism or social motivation may reveal some individual preference patterns, but it is unlikely that true preferences in social wants on a voluntary basis will be revealed. Second, a single most efficient solution to the satisfaction of social wants or to the problem of supplying services that are consumed in equal amounts does not exist. The condition of equal consumption does not permit a single most efficient solution. This problem remains even if individual preferences can be determined.

If costs are to be allocated in response to individual preferences, different prices must be charged to various consumers, or different tax assessments must be placed on taxpayers who consume equal amounts of the same service. The condition of equal consumption must apply to all, since it is not possible to exclude anyone from the use of social goods as is done in the case of private goods and services.

The satisfaction of social wants is not related, therefore, to the price which the consumer pays for social goods, because what the

individual pays covers only a small fraction of the total cost. Examples are the expenditures for defense, flood control projects, the expenditure for the judiciary system, and sanitary facilities. Since the consumer knows that benefits are independent of contributions, he cannot be relied upon to make a voluntary contribution. Therefore, some kind of state compulsion is needed.

Taxes imposed by the state to cover the cost of public services may be progressive, proportional, or regressive, depending upon the income elasticity of the goods that satisfy social wants. If the income elasticity of the good is unity, tax contributions will be proportional. If it is below unity, tax contributions will be regressive. If people demand more of the social service as their incomes increase, the elasticity is above unity, and tax contributions will be progressive.[1]

Merit wants are the second type of public wants. Public services which satisfy merit wants include free education, subsidized low-cost housing, and a tax supported school lunch program. Such wants are met by services subject to the exclusion principle and are satisfied by the market within the limits of effective demand. They become public wants when considered so vital to the community that their satisfaction is provided for through the public budget, rather than through individual choices in the marketplace.

Certain public wants may fall on the borderline between private and social wants, where the exclusion principle can be applied to part of the benefits gained but not to all. Examples of these wants are

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[1]Ibid., Ch. 1.

educational services and health measures which are partly free. Such services and measures have personal benefits to the student or patient, but everyone also benefits more in a healthier and better educated community. They can be looked upon as merit services since they benefit the person concerned first.

Administrative Valuation of Public Goods and Services

In administrative valuation[1] market values are used as a starting point. A period characterized by price stability and full employment may be chosen for this purpose. One method of setting such prices would be that "Rates regulated by public utility commissions in a way that takes account of supply and demand functions extending over time, and a wealth of cost data in the regulated private industry, can be used for approximating a solution to the problem of setting rates for water and power produced by multiple purpose projects. Such rate making can be divorced entirely from the problem of cost allocation."[2]

In market valuation, social weighting is accomplished by the distribution of money incomes. The individual allocates his income (weight) among goods and services in response to market prices. In administrative valuation weighting is partly by income when market prices are used as a starting point, and partly by the distribution of political

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[1]S. V. Ciriacy-Wantrup, Resource Conservation: Economics and Policies (Berkeley: University of California Press, Rev. Ed., 1963), pp. 239. "Administrative Price" has no relation to "administered Price" which describes the rigidity of prices under imperfect market conditions.

[2]S. V. Ciriacy-Wantrup, "Cost Allocation in Relation to Western Water Policies," Journal of Farm Economics, Vol. 36, Part 1, pp. 108-129.

rights. The field of rate making is exposed to many political pressures, and valuation based on economic considerations will be only one factor in the decision making process.

Social weighting or evaluation, therefore, cannot be approached with the tools of economics alone. The social significance of people and their preferences depend on their culture of which economics is only one component.

Financial and Economic Feasibility

A financially feasible project is an undertaking which generates revenues equal to all costs, including interest on funds borrowed to finance the project. The Bureau of Reclamation projects are considered financially feasible if it is expected that the beneficiaries will return all reimbursable costs. Costs attributed to flood control and navigation functions are non-reimbursable. Costs attributed to irrigation are reimbursable without interest. Irrigation, municipal water, and recreation represent the main types of salable services from watershed projects.

For financially feasible projects, the present value V_0 must equal or exceed zero. Capital outlays are considered as costs and monetary receipts as incomes, and such streams are discounted at the rate of interest at which the funds required are actually borrowed or obtained.

Economic feasibility means that the economic valuation of the benefits exceeds the economic valuation of the costs. Here again, V_0 must be positive, but the valuation placed on costs and benefits may

diverge from actual monetary outlays and receipts, and the discount rate may diverge from the actual borrowing rate.

The Water Resources Policy Commission stated: "Financial feasibility has been urged by some as the determining factor in evaluation, that is, they believe that all water resources projects should be self-liquidating. This view implies that the Federal agencies should seek out business opportunities wherever they may be found in the water resources field. The basic fallacy in such reasoning is that it seeks to transfer to public investments the limitations common to private investments. The Federal Government seeks to conserve and develop the Nation's natural resources for the general welfare and not for profit. Hence, financial feasibility is not the same as economic feasibility. Financial costs and returns should be considered in the analysis, but financial feasibility alone should not determine the desirability of a program. For this reason the Commission is recommending that Congress eliminate the requirement that irrigation projects show financial feasibility."[1]

It is true that financial feasibility by itself is a narrow criterion for evaluation, as the Commission suggested. But to eliminate financial feasibility completely would adversely affect the economic feasibility criterion. The existence of cost-sharing requirements, or the requirements of local organizations and individuals to bear project costs or pay for project services would reduce promotional activities and pressures for uneconomic projects that are supported by local

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[1]The Report of the President's Water Resources Policy Commission, op. cit., p. 59.

interests largely because the general public is expected to bear the bulk of the costs.

CHAPTER V

A SELECTED CASE STUDY: A DRAINAGE AND FLOOD CONTROL PROJECT IN SOUTHWEST DADE COUNTY[1]

The Southwest Dade County project of the Central and Southern Florida Flood Control District will be used to illustrate the effects of using alternative methods of evaluating projects. A summary of the economic aspects of the Corps of Engineers Survey Review report of this project follows:

Miami and surrounding urban communities are located on a low coastal ridge which ranges in elevation between 10 and 15 feet above mean sea level. The ridge extends southward from Miami to the vicinity of Homestead and Florida City. Land elevations west of the ridge slope gradually into the low lands known as the Everglades.

The purpose of the plan is to solve the drainage and water control problems. The plan does not include any water power development facilities for municipal and industrial water supply, recreational development, or pollution abatement. Lands between the ridge and Levees 31 N and 31 W will be drained to the south and east through authorized project canals, as shown in Figure 1. The plan considers facilities needed to provide primary drainage for 193 square miles of flat, poorly drained land in Southwest Dade County for agriculture.

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[1]Central and Southern Florida Flood Control District. Survey-Review Report on Central and Southern Florida Project, Southwest Dade County. (Jacksonville: U. S. Army Engineer District, Corps of Engineers, Jacksonville, Florida, October 15, 1963, Serial No. 41). All maps used in this chapter are from this reference.

The northerly boundary of the area is U. S. Highway 41 and Levee 29 which are adjacent and parallel to each other. The westerly and southerly boundaries are the Everglades National Park. Most of the area is between elevations 6 and 7.5 feet, except for a few areas where elevations range up to a maximum of approximately 10 feet. There is little or no drainage in the study area at the present except for seepage or slow overland flow into the Park. Considerable water ponds after heavy rains or during periods when water levels are high in the park.

Extent and Character of the Flooded Area

The entire area is subject to periodic flooding every year and the lower elevations are flooded throughout the year. Ponded water remains in the area until evaporated or is removed by overland flows and ground seepage. The small existing agricultural developments are located on the higher, better drained lands. Until water control facilities are provided, agricultural development is limited to the higher lands which are subject to an occasional flooding during the winter truck-crop growing season. Construction of the proposed improvements would permit use of undeveloped lands in the area to grow winter truck-crops.

Flood damages are caused both by heavy rains during the dry season which destroy growing crops, and the long duration flooding from rains in the wet season which prevents crops from being planted during the first few months of the truck-crop growing season.

Economic Development

Development of the Area

The greatest economic potential of the area is to facilitate the production of winter truck-crops displaced from the coastal area by urban expansion. The future development of the study area is directly related to a rapidly increasing population. Census data for the County for the period since 1930 and estimated population for the years 1985 and 2010 are given in Table 5.[1]

TABLE 5

DADE COUNTY POPULATION

Year	Population
1930	130,000
1940	267,700
1950	495,100
1960	935,000
1985	2,200,000
2010	3,750,000

The projected population of Dade County in 1985 as estimated by the Metropolitan Dade County Planning Department is about 2.5 million. The projection is in reasonable agreement with the one made by the Corps of Engineers and supports the claim of local interests in the County that the expected increase in population will accelerate the need for development of lands in the area for agriculture in the near future.

[1]Federal Census for 1930-1960, and Dade County Planning Department estimates for 1985 and 2010.

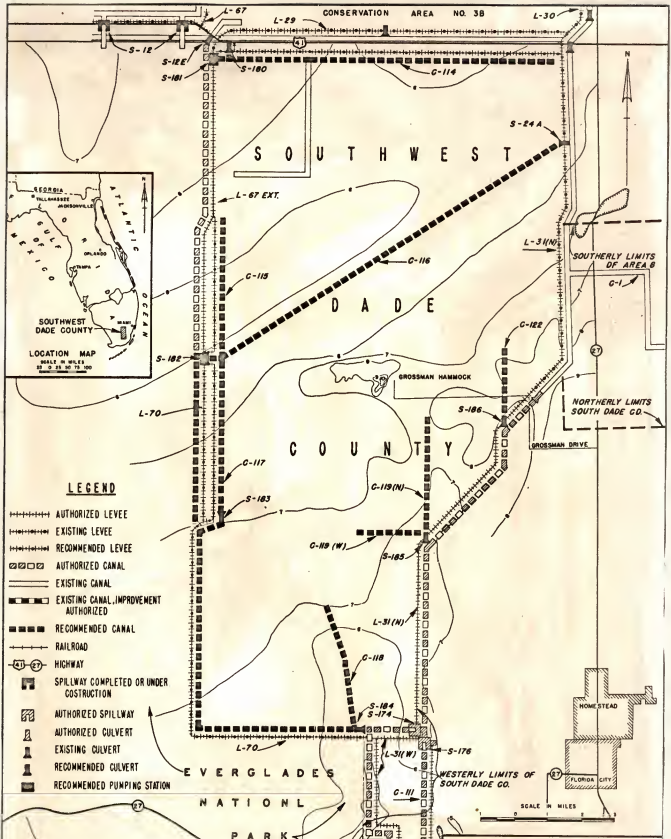
CONSERVATION AREA NO. 3B
L-67
L-29
L-30
S-12
S-12E
S-181
S-180
C-114
S-24A
SOUTHWEST
DADE
COUNTY
L-67 EXT.
C-116
C-115
L-31(N)
SOUTHERLY LIMITS OF AREA B
C-1
C-122
S-182
GROSSMAN HAMMOCK
L-70
S-186
NORTHERLY LIMITS SOUTH DADE CO.
GROSSMAN DRIVE
C-117
C-119(N)
S-183
C-119(W)
S-185
L-31(N)
C-118
S-184
S-174
L-70
S-176
L-31(W)
EVERGLADES
NATIONL
PARK
C-111
WESTERLY LIMITS OF SOUTH DADE CO.
HOMESTEAD
FLORIDA CITY
SCALE IN MILES
S-177
S-175
LOCATION OF HEADQUARTERS, EVERGLADES NATIONAL PARK
TAYLOR SLOUGH
GEORGIA
TALLAHASSEE
JACKSONVILLE
ATLANTIC OCEAN
GULF OF MEXICO
ORLANDO
TAMPA
MIAMI
SOUTHWEST DADE COUNTY
LOCATION MAP
SCALE IN MILES
LEGEND
AUTHORIZED LEVEE
EXISTING LEVEE
RECOMMENDED LEVEE
AUTHORIZED CANAL
EXISTING CANAL
EXISTING CANAL, IMPROVEMENT AUTHORIZED
RECOMMENDED CANAL
RAILROAD
HIGHWAY
SPILLWAY COMPLETED OR UNDER CONSTRUCTION
AUTHORIZED SPILLWAY
AUTHORIZED CULVERT
EXISTING CULVERT
RECOMMENDED CULVERT
RECOMMENDED PUMPING STATION
NOTE
Contours shown are from the following sources.
1. U.S. Geological Survey Quadrangle Sheets.
2. Dade County Topographic Maps (Revised 1955).
3. U.S. Corps of Engineers Surveys.
4. U.S. Soil Conservation Service Surveys.
SURVEY - REVIEW REPORT
CENTRAL AND SOUTHERN FLORIDA PROJECT
SOUTHWEST DADE COUNTY
DRAINAGE AREA AND
PLAN OF IMPROVEMENT
IN 2 SHEETS
SCALES AS SHOWN
SHEET 1
U.S. ARMY ENGINEER DISTRICT, JACKSONVILLE
CORPS OF ENGINEERS, JACKSONVILLE, FLORIDA
SUBMITTED:
APPROVAL RECOMMENDED:
APPROVED:
CHIEF, PLAN & SPEC. BR.
CHIEF, ENGINEERING DIV.
DIR. OF CIVIL WORKS
DRAWN BY: A.S.S.
TO ACCOMPANY REPORT
CHECKED BY: D.T.G.
DATED: OCTOBER 1963
400-28,452

Fig. 1.

South Florida is one of the few areas in the United States capable of producing winter vegetables. As the nation's population expands, there will be an increasing need for the production of these crops. In the year 2015, the demand for fresh vegetables will require the use of all available lands in Southwest Dade County for truck farming. Vegetable production will about double in the next 50 years, according to estimates made by the U.S.D.A., and it is expected that south Florida will provide the bulk of the increased production. Urban developments are pushing agriculture out of the coastal areas and many large truck farms are expected to move into the area under consideration during the next 50 years. Total present development makes up about 2 per cent of the area. Much of the land is owned by large corporations, but there are also a number of small ownerships. There is a large cement plant near the northern edge of the area, a few roads of low order in the area of present development, and a railroad spur to the cement plant near Levee 31. With these exceptions, present access is extremely difficult.

Plans of Improvement

In order to develop Southwest Dade County for agricultural use, water levels must normally be maintained 1 to 2 feet below the average ground surface. Consideration was given to two plans of improvement.

In the first plan, water would be allowed to pond on the area during the wet season, and prevent flooding during the dry season,

because a majority of the truck crops are planted after the wet season. Preliminary studies showed that the majority of the benefits would be obtained from this plan while annual costs would be less than one-fourth of those for the other plan which would prevent flooding during the wet season; however, the second was selected because of the County zoning ordinance requirements.

In the second plan, the water level is controlled during the wet season. A storm of 1-in-10 year frequency during the wet season would cause considerable ponding on Park lands, and canals in the area would be flowing at full capacity. During a flood in the wet season, all runoff from the area would have to be pumped into the Park. If water levels are held below the ground during the wet season, and water is pumped into the Park, seepage rates under the levees will be high and pumps will have to be operated almost continuously during the wet season to remove both the rainfall and seepage. Future development will be controlled by Dade County zoning ordinances which require lands used for urban development to be filled to above the elevation of the design flood. The selected plan of improvement as shown on Figure 1 was designed to control water levels during the winter truck-crop growing season.

The Selected Plan of Improvement

During the dry season which extends from November to April, water levels are usually below the ground surface in the Park around the southern portion of the County. The maximum monthly rainfall during the wet season is 19.5 inches, and in the dry season it is about 6.5 inches.

Facilities should be designed to remove water ponded in the area during a storm with a 1-in-10 year frequency in the dry season in a few days.

During a normal year, about 40 inches of rain can be expected in the 5-month wet season. Evapotranspiration losses of about 30 inches in these months would reduce ponding to 10 inches in the absence of runoff.

During a 1-in-10 year frequency storm, the 5-month rainfall would be about 54 inches, and 24 inches of water would have to be removed from the area. During the dry season, water levels would be maintained at least 1.5 feet below the average elevation of the ground.

Proposed facilities are designed to remove ponded water and seepage from the area prior to planting time for winter truck-crops and to prevent flooding during the storms which can be expected during the growing season. About 24 inches of water could accumulate in the area during a 1-in-10 year wet season, as mentioned before. A portion of this water could be released into the Park by gravity since water levels high in the Park are the result of large releases made through Structure 12.

The proposed Canals 114, 115, 116 and 117 would provide drainage for a 118 square mile area and collect seepage from under the levees. Canals 118, 119, and 122 would provide gravity drainage from the higher lands to the levee 31 borrow canal. Pumping Stations 181 and 182 would remove excess water from the 188 square mile area served by canals 114, 115, 116 and 117, plus the seepage into the area. Culverts 183, 184, 185 and 186 would provide the facilities needed to control water levels in that portion of the area above 7 feet in elevation.

Performance of the Plan

The proposed plan of improvement is designed to remove 15 inches of water a month plus the seepage into the area which occurs after a 1-in-10 year flood. The facilities of the project would permit lowering water levels in the area to desirable stages by about October 10 in a dry year, October 20 in a normal year, and November 10 after a 1-in-10 year flood, if pumps are started on October 1. During wet years, when water is ponded to a depth of more than one foot, the pumps could be started in September for land owners to start planting early in November. If planted in October, crops could be flooded by October storms which are larger than those which occur in the winter season.

During a 1-in-10 year storm in the period from November to April, seepage into the area would be low and pumps could remove 0.5 to 0.75 inches of water a day from the drainage basin. If water levels were 1.5 to 2 feet below the ground prior to the storm, pumps would remove surface ponding in a day or two, and the ground water level could be lowered to the desired stage level in approximately one week.

Table 6 presents a summary of initial and annual costs at current prices for each canal, levee, and structure in the plan of improvement. Initial federal costs are composed of two items: the federal share of construction costs which represents 54 per cent of construction costs, plus engineering costs which represents 77 per cent of the contract price. Non-federal initial costs are composed of three items: (1) the non-federal share of construction costs, which represents 46 per cent of the construction costs; (2) the costs of providing

all lands, easements and rights of way, the payment for relocations and alterations of highways; and (3) the cost of public utilities which may be required for the construction of proposed improvements.

In addition to the costs shown in Table 6, associated costs which are non-Federal are involved.

Associated Works

In addition to the major drainage works, collecting and lateral canals would be necessary to convey the runoff from the land area to the primary canals. It is estimated that about 50 miles of secondary canals would be required. Total initial costs of associated works were estimated to be $1,390,000. Annual costs, based on a 6 per cent rate of interest and amortization and including maintenance, would be $98,300.

Total Annual Economic Costs

The total annual economic costs for the entire plan of improvement are $679,400. Included are financial costs of primary works ($572,500) and of associated works ($98,300) plus $8,600 for land adjustment.

Costs and Benefits

Benefits expected from the plan of improvement are obtained from (1) reduction of flood damages, and (2) increased land use. Estimates of average annual benefits are summarized in Table 7.

TABLE 6

SUMMARY OF FEDERAL AND NON-FEDERAL INITIAL AND ANNUAL COSTS

Item	Construction Costs	Federal Initial Costs	Federal Annual Costs: Interest and Amortization	Non-Federal Initial Costs
CANALS:				
Canal 114	708.4	428.4	16.6	478.8
Canal 115	172.9	104.6	4.1	119.2
Canal 116	1,075.9	650.7	25.3	594.2
Canal 117	364.2	220.3	8.5	206.9
Canal 118	168.9	102.1	4.0	83.8
Canal 119 (W)	77.9	47.1	1.8	45.6
Canal 119 (N)	124.2	75.2	2.9	74.7
Canal 122	120.6	72.9	2.8	91.1
L-70 Borrow Canal	735.3	444.8	17.3	399.7
CONTROL STRUCTURES:				
S-180	37.3	22.5	0.9	17.2
S-181	1,363.0	1,126.8	43.8	857.0
S-182	2,359.8	1,427.3	55.5	1,085.5
S-183	37.3	22.5	0.9	17.2
S-184	93.2	656.3	2.2	42.9
S-185	68.4	41.3	1.6	31.5
S-186	37.3	22.5	0.9	17.2
TOTAL	8,044.6	4,865.3	189.1	4,162.5

TABLE 6—Extension

Non-Federal Annual Costs			Total Costs, Federal and Non-Federal	
Interest and Amortization	Maintenance and Operation	Total	Initial	Annual Financial
20.4	4.3	24.7	907.2	41.3
5.1	1.6	6.7	223.8	10.8
25.3	4.8	30.1	1,244.9	55.4
8.8	1.8	10.6	427.2	19.1
3.6	1.3	4.9	185.9	8.9
1.9	0.7	2.6	92.7	4.4
3.2	1.3	4.5	149.9	7.4
3.9	1.0	4.9	164.0	7.7
17.0	5.9	22.9	844.5	40.2
0.7	2.3	3.0	39.7	3.9
36.5	75.0	111.5	1,983.8	155.3
46.3	100.0	146.3	2,512.8	201.8
0.7	1.1	1.8	39.7	2.7
1.8	2.3	4.1	99.2	6.3
1.3	1.7	3.0	72.8	4.6
0.7	1.1	1.8	39.7	2.7
177.2	206.2	383.4	9.027.8	572.5

TABLE 7

ESTIMATES OF BENEFITS AND COSTS

Type of Benefit	Estimated Average Annual Benefits	Per Cent
Prevention of Flood Damages	$ 260,700	9.6
Increased Land Use	2,464,300	90.4
Total	2,725,000	100.0

$$\text{The benefit-cost ratio} = \frac{\text{Average annual Benefits}}{\text{Annual Economic Costs}} = \frac{2,725,000}{679,400}$$

$$= 4.01$$

Benefits from the reduction of flood damages are the differences between the estimated average annual damages that will occur during the next 50 years with the plan of improvement, and those that will occur without the land use that will prevail without the benefits in the absence of a flood control project. All benefits and damages reflect current price levels. All benefits were discounted for the 50-year period 1965-2015 using compound interest and an interest rate of 3 per cent.

Existing and Future Land Use

Existing Land Use

Currently it is estimated that 3000 acres in the area under consideration are used periodically for vegetable growing on a seasonal

basis. Also, 640 acres are in a recreational use, namely, Mineral Springs and Lake Checkika. The Federal Aviation Agency uses 640 acres for its overseas communication facilities. Existing land use is shown on Figure 2.

Future (2015) Land Use Without the Project

Development will increase as existing croplands in other parts of Dade County are replaced by urban development and as new lands are needed for more production. Considerable agricultural expansion can be expected to take place on the higher lands (above elevation 7 feet) and vegetables will be produced during the winter season exclusively. Most of the area cannot be effectively utilized unless water control is provided at least during the winter growing season. Future land use without the project is shown on Figure 3.

Future (2015) Land Use with Project Incentive

It is estimated that the project would result in an additional 78,300 acres of vegetable crops grown annually by the year 2015. An allowance of 10 per cent for roads, canals, building, and other non-productive areas was taken into consideration in arriving at the additional acreage. The expected land use for the year 2015 with project incentive is shown on Figure 4. Table 8 gives existing land use and land use expected by the year 2015 with and without project incentive.

The weighted average crop value at the time of flood occurrence would be $323 an acre. This unit value was used in estimating flood

damages for unimproved drainage conditions. Flood damages prevented are the difference between annual damages with existing drainage facilities and annual damages with improved drainage facilities. Estimated flood damages are summarized in Table 9.

TABLE 8

LAND USE IN SOUTHWEST DADE COUNTY

Land Use	With Existing Facilities 1963	2015	With Project 2015
Vegetable	3,000	28,800	115,840
Recreation Area	640	640	640
Federal Aviation Agency Facilities	640	640	640
Undeveloped	119,240	93,440	6,400
Total	123,520	123,520	123,520

Discounting procedure showed average annual equivalent flood damges prevented for the Southwest Dade County area to be $260,700.

Increased Land Use

Data on vegetable crop production are shown in Table 10. The weighted average annual net return from vegetable crop production in Dade County during the past 5 years amounts to $138 an acre under flood free conditions. This average annual net return is used to evaluate the annual return from the expected change in land use. The increased land use benefits are discounted using compound interest factors and an interest rate of 3 per cent.

TABLE 9

SUMMARY OF ESTIMATED ANNUAL FLOOD DAMAGES AND DAMAGES PREVENTED BY PROPOSED IMPROVEMENTS

Land Use Year	Annual Flood Damages		Annual Flood Damages Prevented
	With Existing Drainage Facilities	With Improved Drainage Facilities	
1963	$ 50,000	$ 12,000	$ 38,000
2015	1,320,000	305,000	1,015,000

TABLE 10

VEGETABLE CROP PRODUCTION IN DADE COUNTY
5-YEAR AVERAGE (WINTER SEASON)

Crop	Acres Harvested	Net Return Per Acre	Total Return
Pole Beans	2,300	$211	485,300
Snap Beans	690	41	38,300
Cabbage	440	-62	-27,300
Sweet Corn	629	27	17,000
Cucumbers	238	284	67,600
Lettuce	132	238	31,400
Potatoes	7,830	11	86,100
Squash	980	164	160,700
Tomatoes	15,544	159	2,471,500
Total	28,783	115	3,320,600

The Weighted net return per acre = $\frac{3,320,600}{28,783}$

= $115

115 x 1.2 = $138 net return per acre on flood-free land.[1]

Benefit and cost data for the proposed plan of improvement are summarized in Table 11. The data include associated works in addition to primary works.

TABLE 11

SUMMARY OF COSTS AND BENEFITS

Total Initial Costs	$10,417,800
Total Annual Economics Costs	679,400
Total Annual Benefits	2,725,000
Excess of Benefits over Costs	2,045,600
Benefit-Cost Ratio	4.01

[1]The ratio 1.2 was used to convert to flood-free conditions. This ratio is based on experience in Dade County. Analysis of flood damages in the County indicates higher unit flood damages, but the ratio was used for conservative purposes.

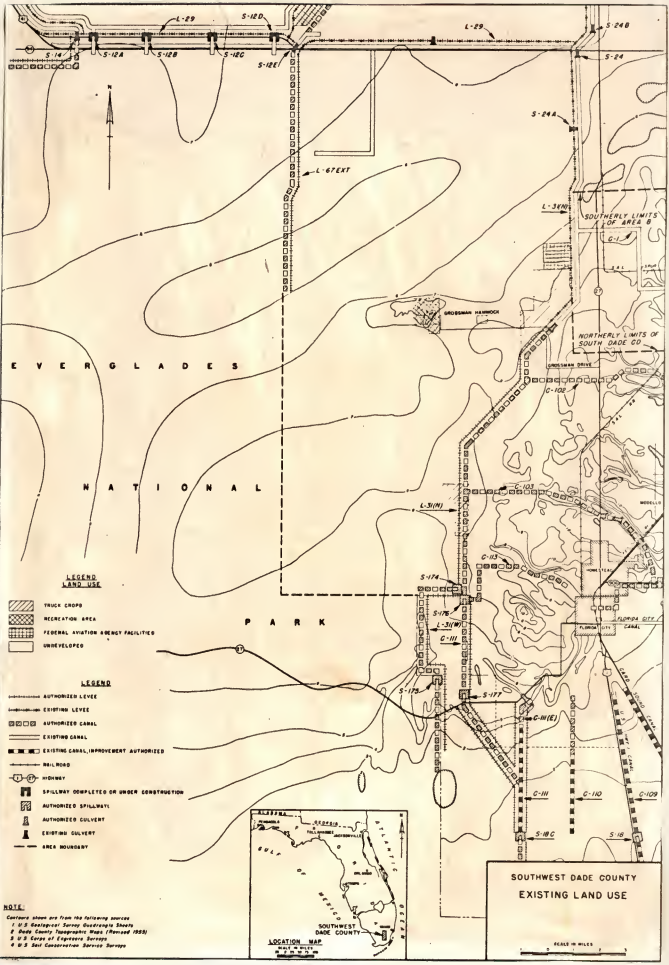
L-29
S-12D
S-12A
S-12B
S-12C
S-12E
S-14
S-24B
S-24
S-24A
L-67EXT
L-31N(I)
SOUTHERLY LIMITS OF AREA B
C-1
GROSSMAN HAMMOCK
NORTHERLY LIMITS OF SOUTH DADE CO.
C-100
C-103
L-31(I)
C-103
S-174
S-176
L-31(W)
C-111
S-175
S-177
C-111(E)
C-111
C-110
C-109
S-18C
S-18
EVERGLADES
NATIONAL
PARK
FLORIDA CITY CANAL
LEGEND
LAND USE
TRUCK CROPS
RECREATION AREA
FEDERAL AVIATION AGENCY FACILITIES
UNDEVELOPED
LEGEND
AUTHORIZED LEVEE
EXISTING LEVEE
AUTHORIZED CANAL
EXISTING CANAL
EXISTING CANAL, IMPROVEMENT AUTHORIZED
RAILROAD
HIGHWAY
SPILLWAY COMPLETED OR UNDER CONSTRUCTION
AUTHORIZED SPILLWAY
AUTHORIZED CULVERT
EXISTING CULVERT
AREA BOUNDARY
NOTE:
Contours shown are from the following sources
1. U.S. Geological Survey Quadrangle Sheets
2. Dade County Topographic Maps (Flown-out 1953)
3. U.S. Corps of Engineers Surveys
4. U.S. Soil Conservation Service Surveys
LOCATION MAP
SCALE IN MILES
SOUTHWEST DADE COUNTY
SOUTHWEST DADE COUNTY
EXISTING LAND USE
SCALE IN MILES

Fig.—2.

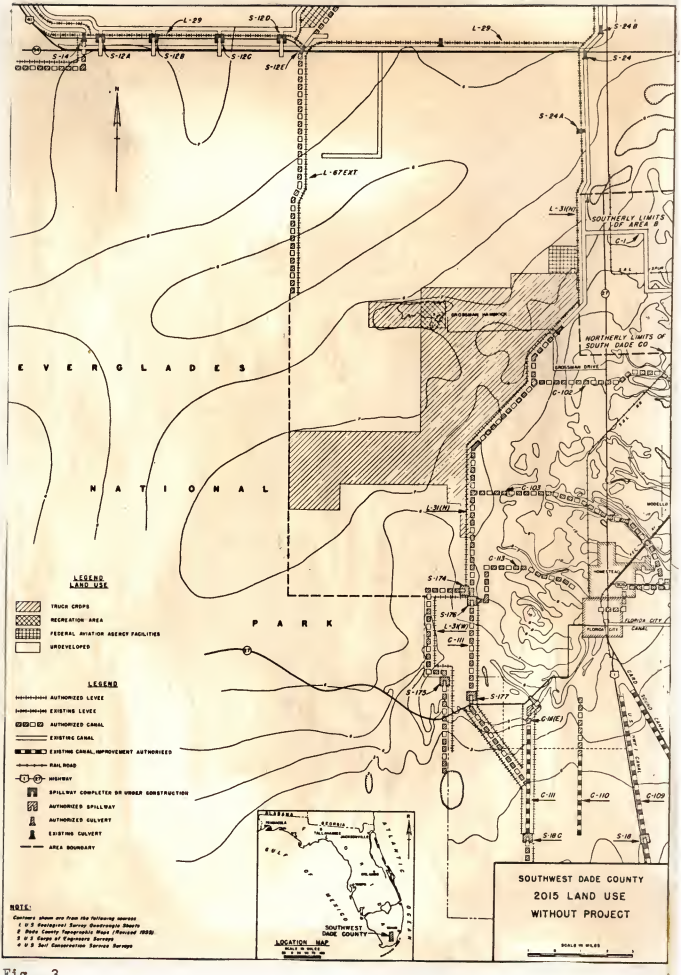
L-29
S-120
S-12A
S-12B
S-12C
S-12D
S-14
L-67EXT
S-24B
S-24
S-24A
L-31(N)
SOUTHERLY LIMITS OF AREA B
C-1
NORTHERLY LIMITS OF SOUTH DADE CO.
LOUISIANA DRIVE
C-102
C-103
C-103
S-174
S-176
L-31(W)
C-111
S-175
S-177
C-1(E)
C-111
C-110
C-109
S-18C
S-18
EVERGLADES
NATIONAL
PARK
LEGEND
LAND USE
TRUCK CROPS
RECREATION AREA
FEDERAL AVIATION AGENCY FACILITIES
UNDEVELOPED
LEGEND
AUTHORIZED LEVEE
EXISTING LEVEE
AUTHORIZED CANAL
EXISTING CANAL
EXISTING CANAL, IMPROVEMENT AUTHORIZED
RAIL ROAD
HIGHWAY
SPILLWAY COMPLETED OR UNDER CONSTRUCTION
AUTHORIZED SPILLWAY
AUTHORIZED CULVERT
EXISTING CULVERT
AREA BOUNDARY
NOTE:
Contours shown are from the following sources:
1 U.S. Geological Survey Quadrangle Sheets
2 State County Topographic Maps (Revised 1955)
3 U.S. Corps of Engineers Surveys
4 U.S. Soil Conservation Service Surveys
LOCATION MAP
SCALE IN MILES
SOUTHWEST DADE COUNTY
SOUTHWEST DADE COUNTY
2015 LAND USE
WITHOUT PROJECT
SCALE IN MILES

Fig.—3.

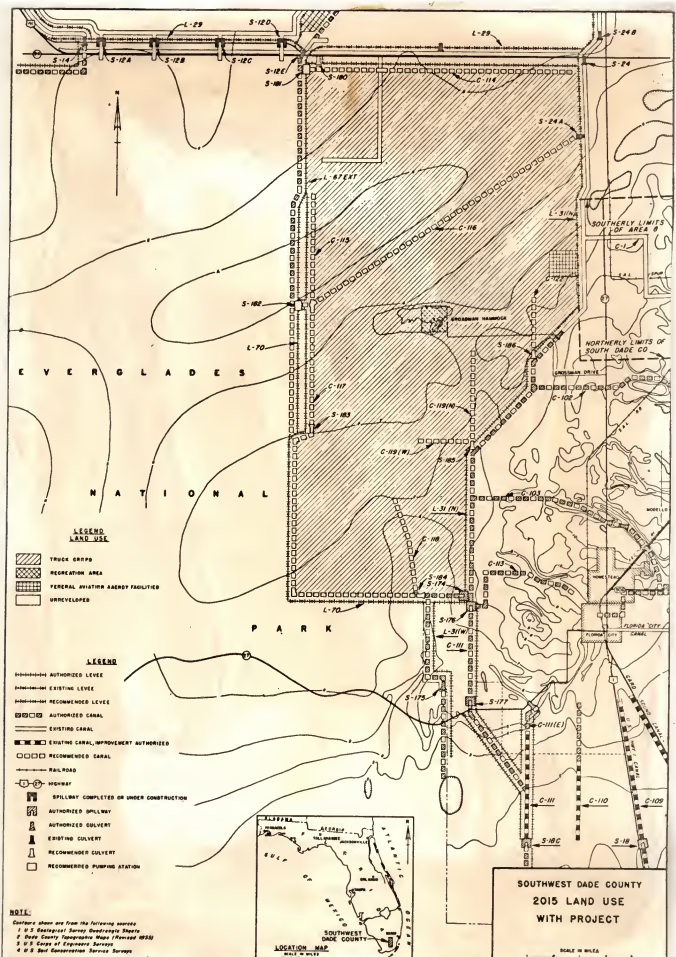
L-29
S-120
S-24B
S-14
S-12A
S-12B
S-12C
S-12E
S-119
S-190
C-114
S-24
S-24A
L-31N(E)
SOUTHERLY LIMITS OF AREA B
C-115
C-116
C-113
S-182
L-70
EVERGLADES
NORTHERLY LIMITS OF SOUTH DADE CO.
S-186
C-117
C-102
C-111/116
S-183
C-119(W)
C-103
NATIONAL
L-31(N)
C-118
C-104
S-174
S-176
L-70
PARK
L-31(W)
C-111
S-175
S-177
C-111(E)
C-110
C-109
S-18C
S-18
LEGEND
LAND USE
TRUCK CROPS
RECREATION AREA
FEDERAL AVIATION AGENCY FACILITIES
UNREVELOPED
LEGEND
AUTHORIZED LEVEE
EXISTING LEVEE
RECOMMENDED LEVEE
AUTHORIZED CANAL
EXISTING CANAL
EXISTING CANAL, IMPROVEMENT AUTHORIZED
RECOMMENDED CANAL
RAILROAD
HIGHWAY
SPILLWAY COMPLETED OR UNDER CONSTRUCTION
AUTHORIZED SPILLWAY
AUTHORIZED CULVERT
EXISTING CULVERT
RECOMMENDED CULVERT
RECOMMENDED PUMPING STATION
NOTE:
Contours shown are from the following sources
1 U S Geological Survey Quadrangle Sheets
2 Dade County Topographic Maps (Revised 1953)
3 U S Corps of Engineers Surveys
4 U S Soil Conservation Service Surveys
LOCATION MAP
SCALE IN MILES
SOUTHWEST DADE COUNTY
SOUTHWEST DADE COUNTY
2015 LAND USE
WITH PROJECT
SCALE IN MILES

Fig. 4.

CHAPTER VI

THE ECONOMIC IMPORTANCE OF LAND

Land as a Factor of Production and as a Store of Wealth

In most water resource development projects, land is both a major item of cost and a medium through which benefits are distributed.

Land is generally considered to be a unique factor of production because it has two quite different attributes, both of which contribute to its economic value.

First, land derives value from its contribution to the production of goods and services at the present time, in much the same manner as labor and capital. And if land played no other role in the economy, it might well be handled in the same manner as capital. Secondly, land derives an additional value from the fact that the amount of space on the earth's surface is fixed in nature. The value of that portion of the economic value of land that is attributable to the scarcity of space with respect to the demand for it increases as the population increases and as income rises. Part of the value which is derived by other factors of production tend to be capitalized into land value as a result of the fixed supply of land as the process of economic development continues. With economic growth, more people hold land for the increase that may take place in its value in the future. In many instances the present worth of future income from land,

discounted at the prevailing rates of interest, exceeds the present worth of the current net income from its use as a "factor of production." When the returns from using land at the present time are sufficiently high to pay all costs of holding it—including opportunity costs and taxes—the cost of the difference between the present worth of the future value and the present value are zero. In other words, the owner is speculating in the future land values for nothing. Thus a low property tax makes it more profitable for land owners to speculate on the future value of land than high taxes. On the other hand when the present worth of the future value of land is high in relation to its value as a factor of production at the present time, owners prefer to pay taxes and allow the land to remain idle. Under these circumstances land is being used as a store of future wealth or as a medium for speculation, rather than as a factor to produce goods and services. In Professor Lassiter's words,

> When the economy of any area experiences rapid growth, land prices are found to be affected by speculation. Speculative activities have undoubtedly increased in anticipation of the completion of the Central and Southern Florida Project.[1]

As an economy develops, two developments with respect to the agricultural sector have been observed. First, the proportion of aggregate inputs which are required to produce farm products begin to decline. Second, land as an input to produce farm products does not increase with an increase of food production, despite the fact that

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[1]R. L. Lassiter, An Analysis of the Movements in Agricultural Land Prices and Values in Palm Beach County, Florida, 1940-1955 (Published Dissertation, University of Florida, January, 1957).

less labor is required in the agricultural sector than formerly.[1] Whenever both of these phenomena occur, land declines in relative importance in the economy although its value may increase.

The fact that land as a factor in the agricultural production of goods and services has not increased relative to the other factors which are used to produce food, has been proved to be valid for the technically advanced committee. The economic development which characterized these communities has resulted in improved production possibilities.

For the first development, it is necessary that the new and better production possibilities which take place in the whole economy include improvements in the production of farm products. The advances in techniques, the use of more capital, and the improvements in organization have to be applied to agricultural as well as the other sectors of the economy. In many parts of the world, the techniques for using land have made it possible to increase the production of food more rapidly than the demand of a growing population for food is increasing.

Agricultural land as an input to an increasing extent comes to consist of capital improvements that are attached or added to land. The advanced communities are less dependent on the original and natural properties of the land input. As a consequence of these developments, agricultural land has been declining markedly in its economic importance, and such a trend is likely to continue.

In an advanced economy, income opportunities are higher and more plentiful in the non-agricultural sectors of the economy than in

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[1] T. W. Schultz, The Economic Organization of Agriculture (New York: McGraw-Hill, 1953), pp. 125-145.

agriculture. In countries where the economy is predominantly agricultural, land has much more importance in the life of the people as a means of living or a factor in the production of goods and services. In the latter countries speculative activities have a more disruptive effect on economic development, in addition to the political unrest caused by such activities. One possible solution to this situation is to levy a speculative tax high enough to stimulate its use in the current production of goods and services.

The Impact of Property Tax on Land Values

The use of land as a means of either allocating costs or distributing benefits from a water resource development project is complicated by the fact that taxes are levied on real estate rather than land and real estate includes both the land and the capital attached to it.

Taxes on Improvements

If taxes are levied on improvements, owners will not improve the land unless the returns from the improvement are large enough to pay the taxes and yield a rate of return on the capital comparable to the returns that might have been earned on other forms of capital. For this reason capital will not be invested in land improvement as rapidly as other forms of capital are accumulated. Likewise if taxes are levied on improvements, owners will not replace or renew them unless they are able to earn enough returns to justify the renewals or replacements,

or to invest in additional improvements. Such a tax cannot be shifted during the lifetime of the improvements, and it tends to increase the price of the products and services which are made possible by such improvements. Ultimately, the tax will be shifted to the consumer in the form of higher product prices. The tax on improvements will thus tend to slow down the rate at which land is improved.

Exempting capital improvements on land from taxation or taxing these improvements at a reduced rate are possible solutions to this problem.

Taxes on Land

If a tax reduction is applied strictly to land (the original and natural properties of the soil), it will tend to create a favorable condition for tax capitalization into land values, because investment in real estate would become more attractive since the cost of holding land for higher future income is low. This would create a favorable condition for land speculation, and the price of land would tend to increase. One possible solution to this problem would be to tax unimproved lands at the same rate as improved lands, and either eliminate or reduce the taxes levied on the capital improvements.

The property tax suggested before is a tax levied strictly on land and not on the capital improvements added or attached to it. But this solution is more difficult to apply to developed than undeveloped lands. In Professor McPherson's words,

> In practice, the value of land is seldom assessed separately when it is combined with capital in any form. Land is taxed

> at the same rate as capital and the combination generally is called real property or real estate. The value of land per se is seldom established except in the case of undeveloped land or by appraisors who endeavor to build up the value of real property from the value of its components.[1]

The Market Value as a Basis for the Tax

In the case study if it is assumed that the market value of unimproved land before the project is $100 per acre, this value becomes the basis for the ordinary property tax. The tax levy is not based upon an increase in net productivity of $138 per acre, because the increase is due to capital improvements.

The increase in the present worth per acre is $138 capitalized at .05 interest rate for the period 1965-2015, or

$$V_0 = 138\left[\frac{(1 + .05)^{50} - 1}{(.05)(1 + .05)^{50}}\right]$$

$$= (138)(18.24) = \$2517$$

The present worth per acre in 1965 is, therefore, $2517 + 100 = $2617. This value may differ from the market value. In the case of the high speculative tax, the levy is based on a market value per acre of not less than $2617, because it is assumed that the speculator leaves his land idle or puts it in a lower use than that planned in the project, in anticipation of an increase in net income of more than $138 per acre.

The market value of land is assessed for property tax purposes according to agricultural value. Under ordinary circumstances valuation

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[1] W. K. McPherson, The Impact of Area Development on Land Resources. Proceedings Agricultural Economics and Rural Sociology Section, Association of Southern Agricultural Workers, Vol. II, Jacksonville, Florida, 1962 (mimeo), pp. 9.

of agricultural land may be assessed at a higher value because it has a potential use for other purposes. In the case study the projected land use for the next 50 years is agricultural, and land is assessed, therefore, according to its agricultural market value.

CHAPTER VII

METHODS OF ALLOCATING PROJECT COSTS AMONG BENEFICIEARIES

In order to foster the economic development desired, the resource development of a region must be planned in such a way as to ensure the achievement of project objectives and the realization of its benefits by beneficiaries. The extent to which these goals are achieved depends in part on the use the owners make of their land. In general, the owners of land that has been enhanced in value by a project may:

1. Increase their annual income by using the land in the manner called for by the project plan;
2. Sell the land and thus obtain as much of the future project benefits as a buyer will pay; or
3. Allow the land to lie idle until the present worth of future earnings exceeds the present worth of the stream of income in the use called for in the plan.

The project goals can best be attained by making a different allocation of costs for each of these three types of beneficiaries.

Owners Capturing Project Benefits by the Use of Land According to Plan

If the owners of land to whom the benefits of resource development projects accrue pay the full value of the benefit received, there is no incentive left for them to participate in the undertaking. Land owners must be given enough incentive to induce them to use their land according to the project plan.

If, on the other hand, beneficiaries are not required to pay anything for the benefits received, another problem is created. Local organizations and individuals are encouraged to promote activities and exert political pressures to initiate projects that may not be in the public interest. Such projects are demanded by local interests because the general public bears the cost of providing benefits that accrue to a relatively small number of people.

In the case of flood control, the benefit cannot be withheld from the individual who refuses to pay for it, therefore, it is non-marketable. The benefit has some but not all of the characteristics of a social good such as the national defense, primarily because all people do not benefit equally from it. The benefit from flood control is limited to the area protected by the project, therefore, the service has some of the elements of a merit good. On the other hand, drainage is a service which under some circumstances is completely private, and under others has many elements of public service. The extent to which the service provided satisfies social wants is a major factor in determining what portion of the cost of the project should be borne by each type of beneficiary.

A compromise between requiring the beneficiaries to pay either the full value of the benefits or none of the project's costs is to require the beneficiary to pay for all project costs, but excessive assessment charges, i.e., charges that exceed the cost of the service, could cause under-utilization of the project services, and in the end,

result in a failure to realize the full benefits of the project. In Chapter VIII, the method of cost-sharing is discussed and applied to the case study of Chapter V.

Owners Who Capture Project Benefits By the Sale of Land

If the distribution of benefits provided for present and future producers is to be made wide and durable, the benefits must be extended to the last year of the project's life. This means that the benefits can be used to produce continuous streams of income throughout the life of the project.

Instead of using the benefits of a project to produce a stream of income in accordance with the project plan, the landowners may sell this stream of income. By doing this the original land owner can capture all or a major part of the project benefits without helping to carry out the plan. One means of requiring such a land owner to pay his share of the project cost is a land-value increment tax which could be levied. Collection takes place when land is sold, because the actual capitalization of the project benefits into land values can operate only through sale or exchange. The market value of land between sales could be used as the tax base. Such a tax would be similar to the capital gains tax, except its applicability is exclusive to land. A land value increment tax would be a progressive tax, and looked upon as a tax on increments of private income, similar to private income from an increase in the value of other factors of production. When land is sold, it is no longer a factor of production or a means of earning a living for the

original owner. Instead it becomes part of the owner's worth or liquid assets and must be regarded and treated like other sources of private income for the purposes of taxation.

The idea that a tax on the incremental increase in land value is progressive may be substantiated by an examination of the capital gains tax.

The Capital Gains Tax

Capital gains arise from the net appreciation in the value of an asset. The value of land may be increased by investing in its improvement or because of its location with respect to other land. In either case capital gains are the difference between the cost of the land and any improvements that may have been put on it and the selling price. The main capital assets subject to this tax are investment securities and real estate. A capital gain or loss is realized only through actual exchange or sale.

Capital gains taxation discourages people from selling or disinvesting, because the gain or net appreciation is then subject to this tax. But capital gains get different and more favorable treatment compared to the private income to which the progressive income tax is applied. This differential and favorable treatment of capital gains as compared with other income encourages capital formation.

Treatment of Capital Gains

According to the Internal Revenue Code of 1954 which is currently applied, gains or losses are considered short-term if the assets are held six months or less. All others are long-term gains or losses. The difference between long-term gains and long-term losses gives net long-term

gains or losses; and similarly with short-term net gains or losses. Putting the net long and short-term gains or losses together, gives six results or possibilities.[1] Consider the net gain possibilities.

Net Gain Possibilities

These are:

a. Net long-term gain minus net short-term loss = net gain. In this case, the taxpayer is free to choose one of two ways. In either case 50 per cent of the net gain enters into tax computation:

   (1) He may enter the 50 per cent of the net gain as gross income and add it to other income to which the progressive income tax is applied.

   (2) Pay a tax at a flat rate of 50 per cent on the 50 per cent of the net gain. The tax here, then, is a flat rate of 25 per cent. This amount is added to the progressive income tax which is applied to other income. Taxpayers who receive large income from long-term net gain usually favor this alternative.

b. Net short-term gain minus net long-term loss = net gain. In this case the whole net gain is included in the gross income to which the progressive income tax is applied. It is the result of a net short-term gain, and is treated like other private income.

c. Net long-term gain plus net short-term gain = net gain. In this case the taxpayer has to separate the two to be treated differently. The net long-term gain is treated as in "a" and the net short-term gain is treated as in "b."

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[1]Philip Taylor, The Economics of Public Finance (New York: McMillan Co., Third ed., 1961), pp. 398-399.

We conclude from this that long-term gains have been granted a favorable treatment. Such a treatment makes the long-term capital gain tax one of the lowest taxes.

Since short-term net gain is treated like other private income, a time interval for short-term net gain must be selected. In the case study project, the time period for the desired land use pattern was 50 years. To make the distribution as wide and durable as possible, the services of the project must be carried to the last year of its life, and net gain is considered a short-term net gain if sale takes place during this period. This is a value judgment similar to the one which considered the short-term period six months or less, and may seem not applicable to politically feasible for reasons outside the realm of economics. In the case of resource development projects, the short-term period has to be at least the period during which the benefits of the project are realized, or the pattern of land use desired takes place.

Another Reason for a Progressive Land-Value Increment Tax

If the short-term net gain period is six months or less, and land sales occur during periods in excess of six months, the long-term net gain tax is applied as explained in "a" above. The maximum limit of such a tax imposed on large amounts of net gain would be a flat rate of 25 per cent. In many instances the value increases of land are substantial. A net gain of one million dollars would be taxed at a 25 per cent rate, the same rate levied on a net gain of only $1000.[1]

[1]Assuming, of course, that the $1000 net gain falls in category "a (2)" above, and the rate will be higher than 25 per cent if "a (1)" is chosen.

Allowing Land to Lie Idle for Speculation Purposes

In this instance a high speculative tax is levied on the market value of land, as explained in Chapter VI. In Professor Lassiter's words,

> Speculation in land is no doubt encouraged by the present Federal tax structure. Because of the highly progressive income tax with rather liberal long-term capital gain provisions, individuals are encouraged to hold land in anticipation of capital gains.[1]

It is implied that in order to discourage speculation, either the provisions of the liberal long-term capital gains must be changed, or a highly progressive income tax could be applied. The latter tax is applied only to short-term capital gains, which further substantiate the idea that the short-term period must cover the lifetime of the resource development project.

The intention of this chapter, as has been seen, is to explore some of the possible methods which may be employed to ensure that a regional economic development process continues without harmful disruptions and according to planned objectives.

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[1]Lassiter, op. cit., pp. 35.

CHAPTER VIII

THE COST-SHARING METHOD

One of the three methods of allocating project costs is to require the beneficiaries to pay the full cost of the project. In the case of the Southwest Dade of the Central and Southern Florida project, the use of this method would call for payments, the size of which would be determined in the following manner.

The initial investment may be repaid by an equal amount R every year, such an amount representing the principal and the compound interest. This is an annuity which is paid at equal intervals of time. The formula R can be written in two forms: $R = S.\frac{1}{s_{\overline{n}|i}}$ or $R = A.\frac{1}{a_{\overline{n}|i}}$

Where S = the amount of the annuity

A = the present value of the annuity. It corresponds to the present value of fixed investment, or it is the initial investment itself.

$s_{\overline{n}|i}$ = the amount of an annuity of 1 per payment interval for n intervals and is written also $\frac{(1+i)^n - 1}{i}$.

$a_{\overline{n}|i}$ has been mentioned in Chapter II, and the following relationship may also be noted between $s_{\overline{n}|i}$ and $a_{\overline{n}|i}$: $\frac{1}{a_{\overline{n}|i}} = \frac{1}{s_{\overline{n}|i}} + i$.

Again, $\frac{1}{a_{\overline{n}|i}}$ is (A_{in}) mentioned in Chapter II. It is the capital charge on fixed investment which appears in the benefit-cost ratio formula, $\frac{B}{C} = \frac{B}{O + A_{in}K}$. Therefore $C = O + (A_{in})K = O + \frac{1}{a_{\overline{n}|i}} \cdot K$.

$\frac{1}{a_{\overline{n}|}i}$ .K = the annual equivalent of the initial investment mentioned in Chapter II and called R.

K here is the initial investment at its present value, or the present worth of the initial investment which is called A in the formula for R.

To apply this assessment method to the case study of Chapter V, the total initial cost of the project is $10,417,800, the life of the project n is 50 years, and the interest rate i is 5 per cent. The annual equivalent of the present value, or the annual payment made by the beneficiaries of the project, which includes the principal and the compound interest is: $R = A \cdot \frac{1}{a_{\overline{n}|}i} = (10,417,800) \cdot \frac{1}{a_{\overline{50}|}.05}$

The value of $\frac{1}{a_{\overline{50}|}.05}$ is taken from the table titled "Annuity Whose Present Value is 1,"[1] and is .05477674.

Therefore R = 10,417,800(0.05477674) = $570,653.12.

Table 12 is the repayment schedule for the initial investment $10,417,800 to be repaid in 50 years.[2]

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[1] Standard Mathematical Tables, op. cit., p. 474.

[2] The First Year:

Outstanding Principal $S = P(1+i)^n = (10,417,800)(1.05) = 10,938,690$
The interest = 10,938,690 - 10,417,800 = $520,890.
570,653.12 - 520,890 = $49,863.12, the principal repaid at the end of the first year. 10,417,800 - 49,863.12 = $10,367,936.88, the principal at the beginning of the second year.

The Second Year:

Outstanding Principal S = (10,367,936.87)(1.05) = 10,886,333.72
Interest = 10,886,333.72 - 10,367,936.88 = 518,396.84. Principal

Fixed and Variable Charges

The $570,653 represents the fixed annual cost that is paid by all beneficiaries whose land benefits from the project. The number of acres which get the project benefit is 115,840. The fixed capital charge, therefore, is $\frac{570,653.122}{115,840}$ = $4.93, per acre. To this amount must be added the annual operating and maintenance charge per acre to those who benefit directly from the drainage and flood control benefits.

The task of allocating the variable costs among the beneficiaries is more difficult. The data needed to estimate the magnitude of these costs is not available. Engineering data will help to determine who benefits directly from the operation and maintenance facilities. In Chapter V it estimated that 28,800 acres of land will be in vegetable crops in the year 2015 with the existing facilities, or without the need for some of the project services. The owners of these acres may be the ones who are exempted from the annual variable costs of operation and maintenance if, according to engineering data information, they benefit only from the project services which are provided exclusively by the facilities that make up the fixed costs.

Some Differences Between the Agency and Present Study Figures

The total initial costs of $10,417,800 are composed of two parts: total initial costs of primary works of $9,027,800, and total initial costs of associated works of $1,390,000.

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repaid at the end of the second year = 570,643.12 - 518,396.84 = 52,256.28.
Principal at the beginning of the third year = 10,367,936.88 - 52,256.28 = etc.

TABLE 12

REPAYMENT SCHEDULE FOR $10,417,800 DEBT AT .05 INTERST RATE

Year	Outstanding Principal at Beginning of Period	Interest at End of Year	Payment $R = A.\frac{1}{a\overline{n}\rceil^{i}}$	Principal Repaid at End of Year
1	10,417,800.00	520,890.00	570,653.12	49,863.12
2	10,367,936.88	518,396.84	570,653.12	52,256.28
3	10,315,806.60	515,784.03	570,653.12	54,869.10
4	10,260,811.51	513,040.58	570,653.12	57,612.55
5	10,203,199.96	510,159.95	570,653.12	60,493.17
6	10,142,705.79	507,135.29	570,653.12	63,517.83
7	10,079,188.96	503,960.40	570,653.12	66,692.72
8	10,012,495.24	500,624.76	570,653.12	70,028.36
9	9,942,466.88	497,123.34	570,653.12	73,529.78
10	9,868,937.00	493,446.85	570,653.12	77,206.27
11	9,791,730.73	489,586.54	570,653.12	81,066.59
12	9,710,664.14	485,533.21	570,653.12	85,119.91
13	9,625,544.23	481,277.21	570,653.12	89,375.91
14	9,536,168.32	476,808.42	570,653.12	93,844.71
15	9,442,323.62	472,116.18	570,653.12	98,536.94
.	.	.	.	.
.	.	.	.	.
.	.	.	.	.
50	.	.	.	.
Total		18,114,856.00	28,532,656.00	10,417,800.00

The total initial costs of associated works were converted to an annual basis, and discounted at 6 per cent rate of interest to come to be: $R = A \frac{1}{a_{\overline{50}|.06}} = (1,390,000)(.06344429) = \$88,188.$

But this annual cost was mentioned by the agency to be $98,300 because the cost of maintenance of the associated works was included in it. It seems that some annual operating costs were added to the fixed costs, which made the project annual fixed payment (fixed cost) to be $572,500, instead of R = 570,653 as shown in Table 12. Also, a cost of land adjustment of $8,600 was added to the Agency's figure, and the total annual costs (fixed and variable charges) came out to be: 572,500 + 98,300 + 8,600 = $679,400, as mentioned in Chapter V.

The Price Level and the Market Rate of Interest

Changes in the price level have to be dealt with throughout the life of the project. If a steady rise in the price level is anticipated, such a rise results in the depreciation of the money value. In this situation the interest has to be a rate which covers the anticipated depreciation. The creditor is entitled to capital depreciation allowance because repayment is in cheaper dollars. The allowance for monetary depreciation may be incorporated in the "monetary" interest rates in such a way as to make the "real" marginal productivity of capital (the pure interest rate) less than the "monetary" rate by the amount of the depreciation allowance. Some authors[1] state that the market rate of interest should be reduced by

[1]Hirshleifer et al., op. cit., p. 143.

a monetary depreciation adjustment, which they place in the neighborhood of 0.5 per cent a year. This figure, the authors mention, is consistent with the Consumer Price Index which rises about 1 per cent annually, and which they think has an upward bias. The increase in the Wholesale Price Index has been less than 1 per cent a year.

The schedule of payment shown in Table 12 may be changed substantially during the lifetime of the project. A different interest rate may be used each year, and consequently, the schedule of payments would change. The administrative agency could take the outstanding principal at the beginning of each year and discount it at a proper rate of interest. The forces which affect the price level would then be reflected in the interest rate, and this way dollars would be converted into a constant purchasing power.

If the rate of inflation exceeds the monetary depreciation allowance, the creditor will lose and the debtor will gain. The annual amortization and interest payment will be made in cheaper dollars to pay for dollars invested previously with a greater real value of resources. The financial feasibility of the project will have a favorable bias. The project as a debtor (one who pays for the benefits as they are required) will benefit from inflation, but this is not a net gain to the creditor (the supplier of capital at a fixed rate of interest). The loss incurred by the creditor will offset the project's gain.

CHAPTER IX

SUMMARY AND CONCLUSION

Summary

The allocation of all or a portion of the cost among the beneficiaries is often called cost-sharing. The hypothesis of this study is that the costs can be shared in a manner that will achieve an efficient allocation of resources and produce an incidence pattern of benefits consistent with welfare criteria. Throughout this study an attempt was made to substantiate the corollary to this hypothesis: that equity considerations in the methods used to allocate costs can be supplemented by more objective standards of valuation in the development of water resource systems.

Basic Considerations Related to Methods of Allocating Costs

The economic evaluation of development projects.—No single criterion is sufficient for project evaluation.

On any given project a ratio of annual gross benefits to annual total costs in excess of unity shows that some net return may be expected, or that there exists a favorable benefit-cost ratio for the project before construction. Such a ratio provides little on which to judge the relative merits of projects whose ratios are more or less than unity. A project which has high gross returns and also high costs is at a disadvantage however valuable the benefits may be.

One of the most important partial criteria for selecting projects is the maximization of the present net worth for a given investment budget when discounted at the proper rate of interest.

The interest rate and capital rationing.—The basic principle used in the "Green Book" is that the discount rate should equal the expected long term borrowing rate of the agency involved, whether private or government. The Subcommittee on Benefits and Costs recommended a rate of 2.5 per cent on federal and non-federal government costs, and a rate of 4 per cent for private costs and for all benefits.

The low interest rate on federal securities reflects an abnormally low lender's risk. If a project fails to produce the expected benefits the loss is socialized and the taxpayer makes up the loss. Thus, this rate does not measure the full social cost of capital because no allowance is made for the risk of the project.

One suggestion has been to use an interest rate in the benefit-cost analysis equal to that on private capital. But public investment is financed primarily out of taxation, much of which is paid by households, therefore, it would be mainly at the expense of consumption. The interest rate in this case measures the social cost of the household's income which is taxed away for public project investment purposes. Such an interest rate would take into consideration the market rate and is the one which more nearly measures the social cost of capital.

Under capital rationing, the size of the government budget is considered fixed and is not determined by the efficiency of the projects. Capital rationing does not represent a practically important situation.

The marginal internal rate of return is suggested. For the discount rate in the present value calculations. This rate of return makes the present value of the marginal project's receipts equal to the present value of its costs, or it is the rate of discount which makes the present worth of the marginal project zero. One method of determining the marginal internal rate of return is to discount the net benefits at various rates and find the rate at which the budget is exhausted by projects with a positive present worth. At some rate of discount the size of investment is equal to the budget. This rate is equal to the marginal internal rate of return.

The valuation of public goods and services.—The objective of public water resource development projects is often stated as the maximization of national welfare. Even though it reduces the scope of the objective sharply, national income is frequently used to measure national welfare because it can be determined quantitively. When this is done the non-economic dimensions of welfare are excluded and suggests that society is satisfied with any distribution of income the market provides. On the other hand, national income is closely tied to market values and, therefore, must be replaced by the more fundamental principle of economic efficiency. Economic efficiency in itself does not take extra-market values into account, hence when distributional goals and the efficiency of resource use goals conflict, the decision becomes a matter of weighing the alternatives, based on an understanding of the extent and significance of the divergence. The cost of efficiency foregone would measure the cost of choosing the distributional goal. On the other hand, the adverse

effects on distribution which stems from obtaining optimum efficiency may justify the need for relaxing the efficiency criterion.

Wants that cannot be satisfied by the market mechanism are known as public wants. Public wants fall into two groups—social wants and merit wants. Social wants are those which must be consumed in equal amounts by all. People who do not pay for the services cannot be excluded from consumption. Voluntary payments by consumers are not feasible and the market cannot satisfy such wants. An example of such services is defense.

Merit wants are the second type of public wants. Public services which satisfy merit wants include free education, subsidized low-cost housing, and publicly furnished school luncheons. Merit wants are met by services subject to the exclusion principle and are satisfied by the market within the limits of effective demand. They become public wants if they are considered so vital for the community that their satisfaction is provided through the public budget, over and above what is provided through the market and paid for by private buyers.

In administrative valuation of public goods and services market values are used as a starting point. A period characterized by price stability and full employment may be chosen for this purpose. In market valuation, social weighting is accomplished by the distribution of money incomes. The individual allocates his income among goods and services in response to market prices. In administrative valuation weighting is partly by income when market prices are used as a starting point, and partly by the distribution of political rights. The field of rate making is

exposed to many political pressures. Valuation based on economic theory will be only one factor in the decision making process.

Social valuation cannot be approached with the tools of economics alone. The social significance of people and their preferences depend on their culture of which economics is only one component.

Projects are considered financially feasible if the reimbursable costs are expected to be paid by the beneficiaries. Economic feasibility means that the economic valuation of benefits exceeds that of costs. The economic feasibility of a project is independent of its financial feasibility.

In the case of flood control, the service cannot be withheld from the individual who refuses to pay for it, therefore it is non-marketable. It is a public service but it is not completely a social service like defense. Equal consumption by all people does not apply to flood control, because the benefits are limited to the area protected by the project. Benefits from water resource projects, in general, are meritorious. Even for a completely social service like defense, cost-sharing is required.

Agricultural land as a factor of production and as a store of wealth.—In the process of economic development, part of the increased returns to other factors of production would tend to be capitalized into land values as a result of the fixed supply of land. During periods of rapid growth, land values are affected by speculation. People would like to hold land until the present worth of future returns from it

exceeds the present worth of current returns. If the property tax on land is low, the cost of holding land to speculate on its future value is low. This encourages people to use it as a store of wealth or a medium for speculation rather than as a factor in the production of goods and services.

In advanced communities, land as an input has come to consist of capital improvements that have been attached to land. These communities are less dependent upon the original and natural properties of the land input. As a consequence of such developments, agricultural land declines in economic importance. In these communities, income opportunities are superior and more plentiful in the non-agricultural sectors of the economy. In predominantly agricultural economies, land has much more importance in the life of the people as a means of living or as a factor in the production of goods and services. In these countries speculation in land has disruptive effects on economic development and political stability. A high speculative tax on land to stimulate its use in the current production of goods and services is one answer to this situation. Besides, a low property tax on land tends to create a favorable condition for tax capitalization into land values. Since the cost of holding land for a higher future income is low, investment in real estate for speculation purposes is encouraged. Taxation of improved and unimproved land at the same rate, with a low tax levied on capital improvements, encourages investment for current production purposes.

Methods of Assessment

The cost-sharing method.—If the beneficiaries of a public resource development project pay the full value of the benefits received, an incentive does not exist for them to participate in resource development. But in the absence of any charges for the benefits, potential beneficiaries would try to induce the government to construct uneconomic projects, since the general public would bear the cost. Assessment charges that exceed the service cost would cause under utilization of the project services and in the end services are not realized fully by beneficiaries. The actual application of the cost-sharing method is made by mathematical evaluation and finance.

Other methods of assessment.—When land is sold and the project benefits are capitalized into his land sale value, land may put it in a lower use than that sought by the project, or it may be left idle for speculation purposes. Here, some of the possible methods are explored which may be used to ensure that regional economic development continues according to the planned objectives of the project. A land-value increment tax would be levied upon land when sold because the actual capitalization of the project benefits into land values operates exclusively through sale or exchange. The gain in the market value between one sale and another becomes the tax base for the land. Such a tax would be similar to the capital gains tax, but applied only to land. The land-value increment tax would be a progressive tax, because it is regarded as a tax on increments of private income. In the case of the capital gains tax, the short term net gain is treated like other private income. To make

the distribution of the project benfits wide and durable, the services of the project must be carried to the last year of its life, and net gain considered a short-term net gain when sale takes place during this period. The short-term period must be at least the period during which the benefits of the project are realized. If the long-term capital net gain tax is applied during the lifetime of the project, a million dollar net gain is taxed at the same rate as small increments. This means that the marginal social significance of the dollar is the same regardless of who receives it, and that society is indifferent as to who receives the extra dollar from an increased efficiency in resource use. It would be a violation of a basic criterion in welfare economics.

When land is left idle or put in a lower current use for future speculation purposes, the speculation tax is applied.

The above analysis is centered around regional economic development, and for this reason, a case study was selected in order to apply the analysis to an area. A flood control and drainage project was selected in Southwest Dade County, Florida. The survey and review report of the project was prepared by the U. S. Army Engineers, and the project is under the management and supervision of the Central and Southern Florida Flood Control. The analysis of the cost-sharing method was examined in detail, while other important information was used as illustrative material.

Conclusion

In general the study is concerned mainly with economic principles and methodology. It is an outline to a problem and methods of solving

it. The problem is one of regional agricultural development, a problem which has more impact in economies which are predominantly agricultural. A subjective approach to the problem is used for this reason.

The cost-sharing requirement is justified when the evaluation of public goods and services is considered. Benefits from water resource projects are meritorious. Even for completely social services like defense, consumers still must pay the costs.

When the interest rate on public funds is considered, the social cost of such capital is reflected mainly in time preference of consumers, since the source of public funds is revenue derived from the taxation of personal incomes. This is an added justification for the cost sharing requirement.

In taxing capital gains which come from land sales, a progressive land-value increment tax is suggested. Otherwise, it is apparent that if a long-term capital gains taxation is used, the marginal social significance of an extra dollar is the same regardless of who receives it, a result which is inconsistent with welfare criteria.

Value judgments cannot be excluded entirely in matters which involve equity considerations, especailly in matters of wealth distributions. But value judgments were reduced to a minimum, and the analysis is based more on economic principles of land taxation and public finance.

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This dissertation was prepared under the direction of the chairman of the candidate's supervisory committee and has been approved by all members of the committee. It was submitted to the Dean of the College of Agriculture and to the Graduate Council and was approved as partial fulfillment of the requirements for the degree of Doctor of Philosophy.

December, 1964

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